HISTOMORPHOLOGICAL STUDIES ON THE ADRENAL AND THYROID GLANDS OF RABBIT

(Oryctolagus cuniculus)

THESIS

SUBMITTED TO THE

RAJENDRA AGRICULTURAL UNIVERSITY

PUSA (SAMASTIPUR) BIHAR

(Faculty of post-graduate studies)

In partial fulfilment of the requirements

FOR THE DEGREE OF

MASTER OF VETERINARY SCIENCE

(VETERINARY ANATOMY)

BY

RENU SINHA

Registration No.M/VAN/77/98-99

Department of Veterinary Anatomy & Histology

BIHAR VETERINARY COLLEGE

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DEDICATED

TO

LATE FATHER

DEPARTMENT OF VETERINARY ANATOMY AND HISTOLOGY

BIHAR VETERINARY COLLEGE, PATNA - 14

RAJENDRA AGRICULTURAL UNIVERSITY

PUSA (SAMASTIPUR), BIHAR.

C E R T I F I C A T E – I

This is to certify that the thesis entitled **"Histomorphological Studies on the adrenal and thyroid glands of rabbit (*Oryctolagus cuniculus*)"** submitted in partial fulfilment of the requirements for the Degree of **Master of Veterinary Science (Veterinary Anatomy)** of the Faculty of Post-Graduate studies, Rajendra Agricultural University, Bihar is the record of bonafide research work carried out by **Dr. RENU SINHA,** Registration No. M/VAN/77/98-99, under my supervision and guidance. No part of the thesis has been submitted for any other Degree or Diploma.

It is further certified that the assistance and help received during the course of this investigation and preparation of the thesis have been fully acknowledged.

1/12/2002

Dr. M. K. Roy

Major Advisor

Associate Professor and Head,

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We, the undersigned, members of the Advisory Committee of **DR. RENU SINHA**, Registration No. M/VAN/77/98-99, a candidate for the Degree of **Master of Veterinary Science** with major in **Veterinary Anatomy** have gone through the manuscript of the thesis and agree that the thesis entitled **"HISTOMORPHOLOGICAL STUDIES ON THE ADRENAL AND THYROID GLANDS OF RABBIT *(Oryctolagus cuniculus)*"** may be submitted by **DR. RENU SINHA** in partial fulfilment of the requirements for the Degree.

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This is to certify that the thesis entitled **"HISTOMORPHOLOGICAL STUDIES ON THE ADRENAL AND THYROID GLANDS OF RABBIT *(Oryctolagus cuniculus)*"** submitted by **Dr. RENU SINHA,** Registration No. M/VAN/77/98-99, in partial fulfilment of the requirements for the Degree of **Master of Veterinary Science (Veterinary Anatomy)** of the Faculty of Post-Graduate studies, Rajendra Agricultural University, Bihar was examined & approved on 25.05.2001 ~~2000~~.

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Place – B. V. C. Patna

Dated

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1/12/2000

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INTRODUCTION

1. INTRODUCTION

In the recent days, the rabbit breeding has emerged as one of the important enterprises in the foot hills of Himalaya in India, particularly in north-west region. Rabbit husbandry plays a major role in meeting the requirements of meat, fur, pelt and wool. The rabbit have good potential for Indian condition as they are adopted to local temperature and climatic conditions.

Rabbit breeding is gaining continuous momentum by the animal keepers due to the high reproductive rate, small body size, timed ovulatory response with good maternal instinct and ability to use fibrous plant material and agricultural by – products as food. Rabbit has many unique properties in comparision to the large animals as it is easy to handle, simple to care and management. In the field of research too it has proved excellent model system both for human beings and animals.

Considering the overall economic value of rabbits in India, the Veterinary Council of India has incorporated various aspect of this species in newly adopted Veterinary Course Curriculum.

The adrenal and thyroid glands are two important components of endocrine symphony in mammals and avians. Considering the paucity of literature on the structural details of these endocrine glands of rabbit, the present study was undertaken to fulfill the following objectives.

1. To study the histological details of various components of adrenal and thyroid glands in rabbit.
2. To study certain histochemical characters of the different components of adrenal and thyroid glands in rabbit.

The findings of this study will be of immense value for the scientists engaged in the research projects of allied sciences in general and the students in particular.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

2.A. Adrenal gland:

2.A.a. Capsule and Stroma:

Trautmann and Fiebiger (1957) described that the connective tissue capsule of adrenal gland in domestic animals contained few elastic and smooth muscle fibers. Numerous fine vascular connective tissue processes extended from the capsule into the glandular parenchyma. The delicate network of connective tissue fibers of medulla contained few elastic fibers.

Delphia *et al.* (1959) reported the occurrence of lymph nodules in the adrenal capsule of cattle. The capsule also contained cyst like cortical tissue, which resembled the cells from outer layer of the adrenal cortex.

Zimny (1957) observed that the connective tissue components of adrenal gland in the ground squirrel were PAS positive.

Sohal and Chaturvedi (1962) reported that in the capsule of buffalo adrenal, the connective tissue fibers were more compact in the outer zone than the inner zone.

Greep and Deane (1966) described that the mammalian adrenal capsule was composed of thick collagenous fibers and a network of blood vessels, nerves and lymphatics.

Roy (1970) reported that the adrenal capsule of buffalo was made up of outer dense fibrous, middle fibro-muscular and inner fibro-cellular layers. The stromal network was composed of

reticular and collagen fibers. Histochemically, capsule was PAS reactive. A little amount of fat was found in the capsule. The endothelium of capsular blood vessels was positive for alkaline phosphatase.

Banks (1981) described that adrenal capsule of domestic animals was made up of dense white fibrous connective tissue. The trabecules of aerolar connective tissue began from the capsule and invaded the parenchyma at the level of medulla.

Prasad and Sinha (1981[b]) reported that the adrenal capsule and connective tissue trabeculae in domestic animals were moderate to strongly PAS positive and lipids droplets were absent.

Prasad and Sinha (1981[c]) recorded that in domestic animals the thickness of adrenal capsule differed significantly between male and female of all species except for canine.

Dellmann (1987) mentioned that in domestic animals the common thin adrenal capsule was composed of dense irregular connective tissue with occasional presence of smooth muscle fibers. Frequently clusters of cortical cells were seen in the capsule. The thin trabeculae originating from the capsule penetrated the cortex, which rarely entered into the medulla.

Baishya *et al.* (1998) described that the capsule and trabeculae of the adrenal glands in mithum were relatively thicker than that of the yak.

2.A.b. Adrenal cortex:

Adrenal cortex of mammals possessed three different zones viz. outer zona glomerulosa, middle zona fasciculatata and inner zona reticularis as reported by Cupps *et al.*, (1954) in cattle; Trautmann and Fiebiger, (1957) in domestic animals; Sohal and Chaturvedi, (1962) in buffalo; Roy, (1970) in buffalo; Banks, (1981); Prasad & Sinha, (1981) and Dellmann (1987) in domestic animals. Carter and Lever (1954) reported the presence of zona intermedia in the adrenal cortex of mammals. The cellular arrangement showed transition between the zona glomerulosa and fasciculata.

Similarly zona intermedia was observed in the adrenal cortex of different domestic animals viz. Sohal and Chaturvedi (1962) in buffalo; Das *et al.* (1965) in cattle; Yamauchi (1965) in aged cows; Prasad (1978) and Dellmann (1987) in certain domestic animals.

2.A.b.a. Zona glomerulosa:

Cupps *et al.* (1954) observed that the cells of zona glomerulosa in normal bull were columnar in type with vacuolated cytoplasm and vesicular nucleus. The cells were arranged in cords or cylinders. These cells were also seen at the cortico-medullary junctions.

Girod (1960[b]) recorded that in rabbit, no glycogen was found either in its normal state or after submission to the influence of various endocrine factors.

Planel *et al.* (1960) studied the distribution of glycogen in adrenal glands by PAS reaction in mammalians like man, mouse, rat, dog, pig, rabbit, cat, lamb or Guinea pig and horse.

Yamauchi (1961) reported that the glomerulosa cells of bovine adrenal contained acidophilic granules. These granules were considered to represent their normal endocrine activities. PAS positive cytoplasmic granules were also observed in these cells.

Gorbman and Bern (1962) described that mammalian adreno-cortical tissue was characteristically rich in vit.-C. However, the level of ascorbic acid varied considerably with the physiological conditions of the animal.

Sohal and Chaturvedi (1962) reported that the glomerulosa cells of buffalo were spherical or columnar.

Roy (1970) observed that the glomerulosa cells in buffalo were mildly reactive for PAS and acid mucopolysaccharides. These cells were negative for alkaline phosphatase.

Nickerson (1971) recorded that in Mongolian gerbil, the lipid droplets were sparse in zona glomerulosa cells.

Ganguli and Ahsan (1978) reported that activated cells of adrenal cortex contained decreased amount of ascorbic acid and lipid droplets in goats.

Banks (1981) described that in ruminants, this zone consisted of clustered groups of glomeruli. The cells were polyhedral. The nucleus was smaller and less darker than those of the adjacent zone.

Prasad and Sinha (1981^{b}) reported that the zona glomerulosa cells were negative for PAS reaction and weak to moderate positive for lipids.

Dellmann (1987) stated that the zona glomerulosa of ruminants was formed of irregular clusters or cords of cells. Acidophilic cytoplasmic granules were present in the cells of bovine adrenal. In general, the cells of this zone showed lesser degree of lipid accumulation than the cells of zona fasciculata.

2.A.b.b. Zona fasciculata:

Cupps *et al.* (1954) reported that the fasciculata cells of adrenal in bull were round with abundance of granular cytoplasm and vesicular nucleus. The cytoplasmic vacuoles were larger than those in glomeruloa cells.

Trautmann and Fiebiger (1957) described that this zone was thickest of the cortical zones. It was composed of anastomosing radial cellular cords, which were separated from each other by

sinusoids. In cattle, the cells of this zone were larger that those in the other zones. The nuclei were pale and large.

Bell and Weber (1959) reported that the cells of this zone in heifer and cow showed comparatively lesser tendency for lipid accumulation.

Girod (1960[a]) described that in rabbits, the adrenal glands are heavier in male than in those of the female. Histologically a sexual dimorphism was observed which affected the internal zone of the adrenal cortex.

Sohal and Chaturvedi (1962) observed that fasciculata cells of buffalo were polygonal in shape with acidophilic cytoplasm. The nuclei were vesicular and spherical in shape.

Yamauchi (1965) recorded that there was no sharp line of demarcation between zona fasciculata and zona reticularis in the adrenal of heifer and cow. The combined thickness of these two zones increased in older animals than the younger ones.

Iskander and Mikhail (1966) observed lipid rich outer and lipid poor inner parts in the zona fasciculata of camel adrenal cortex.

Roy (1970) reported that in buffalo the zona fasciculata and reticularis did not show clear line of demarcation between them. The fasciculata cells were polyhedral with acidophilic cytoplasm containing vesicular nucleus. These cells contained more lipid droplets and were weak to moderately reactive for PAS stain.

Alkaline phosphatase was not recorded in these cells. The nuclei were Feulgen reactive.

Nickerson (1971) recorded that in Mongolian gerbil, the lipid droplets are numerous in fasciculata cells.

Banks (1981) described that fasciculata cells of domestic animals were cuboidal or polyhedral in shape and were arranged in radial cords. The cells of outer portion of this zone were larger and contained large vesicular nucleus with foamy cytoplasm. Binucleated cells were also common.

Prasad and Sinha (1981[b]) reported that in domestic animals, the cells of zona fasciculata were negative to weak positive for PAS reaction comparatively more concentration of lipid droplets was observed in these cells. They also observed moderate to strong positivity for DNA in the nucleus of zona fasciculata cells in different domestic animals.

Varadaraju and Rao (1982) reported that adrenal cortex of Indian mangoose was rich in glycoprotein lipids and protein bound amino groups.

Dellmann (1987) stated that the cells of this zone were cuboidal or columnar and were arranged in cords. The cell cytoplasm was foamy due to presence of numerous vacuoles from the dissolution of lipid droplets.

2.A.b.c. Zona reticularis:

Cupps *et al.* (1954) found that the zona retiucularis of bull was formed by blending of the cells from other two zones. Some of these cells contained eosinophilic granules in the cytoplasm.

Trautmann and Fiebiger (1957) described that the cells of zona reticularis were closely related to the cells of zona fasciculata both in structure and function.

Sohal and Chaturvedi (1962) reported in buffalo that reticularis cells were smaller in size with more acidophilic vacuolated cytoplasm.

Roy (1970) observed 'light' and 'dark' zona reticularis cells at the deepest zone of adrenal cortex of buffalo. He also observed the isolated cell clusters of cortical tissues in the peripheral zone of adrenal medulla in buffalo.

Nickerson (1971) recorded that in Mongolian gerbil, the lipid droplets were sparse in reticularis cells.

Banks (1981) mentioned that in domestic animals the cells of the zona reticularis were arranged in anastomosing cords. The cells presented dark staining nucleus.

Prasad and Sinha (1981[b]) recorded that in domestic animals the cells of zona reticularis were moderate to strongly positive for PAS reaction and weak to moderatly positive for lipids.

Dellmann (1987) described that cells of this zone in domestic animals were polyhedral with heterochromatic nucleus,

which often showed pyknosis. These cells contained fewer lipid droplets and more lipofuscin granules.

2.A.c. Adrenal medulla:

Trautmann and Fiebiger (1957) described that adrenal medulla of domestic animals was mainly comprised of chromaffin cells containing large pale staining nucleus. In pig and sheep, the cells were columnar. In other domestic animals the cells were polygonal. In addition to these cell sympathetic ganglion cells were also found in abundance in case of ruminants.

Sohal and Chaturvedi (1962) observed that the medullary cells of buffalo adrenal were polygonal in shape.

Wood (1963) reported that with eosin-aniline blue stain the cells of adrenal medulla appeared brownish purple in colour which was suggestive for epinephrine containing cytoplasm of the particular cells. The presence of only adrenaline containing cells was further confirmed with Giemsa stain where epinephrine-containing cells appeared dark in the adrenal medulla of rabbit.

Coupland *et al.* (1964) observed adrenalin and nor-adrenalin containing cells in adrenal medulla of various domestic animals.

Smollich (1965) reported that in ruminants, the medullary cells were arranged in follicles.

Greep and Deane (1966) described in man that he parenchyma of adrenal medulla was composed of sleeves of columnar epitheloid cells. The polarised cells were secretory and contained vesicular nucleus lying towards the base of the cells.

Smollich (1966) reported that in most ruminants, the so called 'A' and 'N' cells of the adrenal medulla could easily be differentiated by their size, shape, position of nucleus and staining reactions.

Zamora *et al.* (1967) observed that the adrenal medulla in calves was composed of outer and inner medullary zones. The cells of the outer zone were columnar with granular cytoplasm and round to ellipsoidal nucleus. The inner zone was composed of aggregates of round or polyhedral cells having granular cytoplasm and round to ellipsoidal nucleus. Histochemically, the cells of outer zone were identified as epinephrine containing cells whereas the cells of inner zone as nor-epinephrine containing cells.

Roy (1970) reported that in the buffalo adrenal, the medullary cells were mildly reactive for PAS and negative for alkaline phosphatase and lipids. Histochemically, adrenaline and nor-adrenaline containing cells were identified and they were located in two distinct zones.

Akolekar and Agrawal (1976) reported that the cortical tissues were frequently found in the adrenal medulla of the goat.

Banks (1981) described that the parenchymal cells of adrenal medulla of domestic animals were large columnar or polyhedral. Sympathetic ganglion cells were randomly distributed throughout the medulla.

Prasad and Sinha (1981[a]) recorded that adrenal medulla in domestic animals showed clear distinct zonations. The characteristic features were follicular formation and strong basophilic staining characters. The fibroarchitecture of the adrenal medulla was formed of collagenous and reticular fibers. Elastic fibers were found in the adrenal medulla of bullock and horse. Patches of cell characteristics of adrenal cortical cells were also found in the adrenal medulla of horse & goat.

Prasad and Sinha (1981[b]) reported that in domestic animals the adrenal medulla was negative to weakly reactive for PAS reaction and moderately positive for DNA.

Dellmann (1987) stated that the chromaffin cells of adrenal medulla were arranged in irregular cords and clusters, separated by a dense network of sinusoidal capillaries sympathetic ganglion cells were distributed either singly or in clusters amongst the chromaffin cells.

Baishya *et al.* (1998) described that the cortico-medullary junction was distinct in both species i.e. mithun and yak. The medullary tissues were arranged into two distinguisable cellular layers viz. one inner and other outer zones.

2.B. Thyroid gland :

2.B.a. Capsule and Stroma :

Trautmann and Fiebiger (1957) described that the thyroid gland of domestic animal was ensheathed by a connective tissue capsule. The interfollicular fat free connective tissue stroma was delicate and well vascularised. The follicles were closely surrounded by a network of delicate reticular fibers.

Bloom and Fawcett (1962) mentioned that in most mammals, the thyroid capsule was three layered. The inner layer was the true capsule and was made up of compact connective tissue which closely adhered with the gland.

Das *et al.* (1965) reported the presence of smooth muscle fibers along with collagen and reticular fibers in the thyroid capsule of the bull and bullock.

Roy (1970) reported that the capsule and stromal tissue in thyroid of buffalo were positive for PAS reaction. The endothelium of the associated blood vessels showed mild reaction for alkaline phosphatase.

Roy *et al.* (1978) observed that the thyroid capsule of the goat was mainly comprised of collagen and reticular fibers with a few elastic fibers. Relative proportion of reticular fibers was more in younger than in the adult ones. There was increase of stroma with the advancing age of goats.

Prasad (1983) reported that thyroid capsule of goat was derived from deep cervical and peritracheal fasciae. It was mainly composed of collagenous and reticular fibers. The elastic fibers in general were absent. The interlobar and interlobular trabeculae were mainly formed by reticular fibers with little admixture of collagenic tissue. The capsule and stroma were

intensely PAS reactive. They were negative for glycogen and acid mucopolysaccharides.

Talukdar and Bordolai (1996) described that in week old Rhino calf, the thyroid gland was covered by capsule which contained collagen, reticular and few elastic fibers. The connective tissue trabeculae from the capsule divided the gland into lobes, lobules and follicles.

Sathyamoorthy and Vijayragavan (1997) described that in Japanese quail, the capsule of the thyroid gland was made up of collagen, reticular and few elastic fibers.

Briet *et al.* (1998) described that the thyroid gland of bird was paired organ with a lenticular profile. The gland was covered by a thin connective tissue capsule which holds adipose cells.

2.B.b. Thyroid Follicles:

Trautmann and Fiebiger (1957) described that in domestic animals, the thyroid follicles were mostly oval or round in shape. Some follicles were tubular or sacculated.

Tomonari (1959) recorded that there was a common tendency of increased follicular size at the periphery and decreased to be immature at the central part of the thyroid glands in cow, horse, pig, cat, dog, guinea pig, rat and rabbit.

Copenhaver (1964) described in man that follicles were structural units of thyroid gland. The follicles differed in shape and size but they were usually irregularly spheroidale. The follicles were filled with gel-like material "Colloid".

Das *et al.* (1965) reported that in bull lobules were made up of numerous follicles and interfollicular primitive cells. The shape of follicles

were mostly circular and oval. The smaller follicles were mostly located towards the periphery and larger one in the centre. In bullock, the interfollicular primitive cells were more abundant. The follicles were arranged in an irregular manner and were smaller in comparison to those in the bull.

Roy (1970) reported that in buffalo, the follicles were mostly oval. However, few follicles were round or irregular in shape. Larger follicles were predominantly present in the deeper part of the gland.

Roy *et al.* (1978) observed that the thyroid follicles in the goat were mostly round or oval. The active follicles were smaller than the inactive ones.

Prasad (1983) reported that thyroid follicles were mostly round or oval in the goat. A few irregular follicles could be seen at 6 months and above age group. The follicular size increased with the increase in age which was significant from age group of 9 months and above.

Sathyamoorthy & Vijayragavan (1997) described that in Japanese quail, the small and medium sized follicles were predominant in younger birds whereas large size follicles were more in matured birds. The follicles were separated from each other by interfollicular connective tissue.

Breit *et al.* (1998) described that in the thyroid gland of birds, the follicles were ovale with a pyramidal top on each end.

Mukherji *et al.* (1998) described that in case of rats, the follicles were irregularly spheroid and varied greatly in shape and size.

Sonap *et al.* (1998) recorded that the follicles were oval in prepubertal, oval to circular in pubertal and large and elongated in castrated animals.

2.B.b.a. Follicular epithelium:

Tomonari (1959) investigated histological structure of thyroid gland in cow, pig, horse, cat, dog, rabbit, rat and guinea – pig. The large follicle had flattened epithelium and were not active in colloid formation and reabsorption while small follicle had columnar epithelium which were presumably synthesizing and secreting certain substances. The discharge of intracellular thyroglobulin was carried out by secretory mechanism identical with that in protein cells of exocrine glands.

Mukherjee *et al.* (1960) found that there was seasonal change in the histology of thyroid in goat and ram. The thyroid activity was decreased in summer and autumn but increased in winter and spring.

Copenhaver (1964) described in man that cellular height of follicles depending upon activity of the thyroid gland. In normal gland, they were cuboidal. But when a follicle was distended with colloid, they become low cuboidal or even squamous. In highly active glands, the cells were tall columnar. The nuclei and cell membrane were distinct and terminal bars were present. In addition to follicular cell another type of cell were present called colloid cell of Langendorff. These cells were filled with colloid having pyknotic nuclei and were degenerating cells.

Das *et al.* (1965) found that the thyroid follicles in bull were lined with cuboidal cells with large spherical nucleus.

Roy (1970) observed that the follicular epithelium in buffalo varied from simple squamous to cuboidal or low columnar type. The cells of active follicles were reactive for PAS. The nuclei were moderately Feulgen reactive.

Roy and Yadav (1975) reported that in buffalo, the follicular cells were positive for PAS, glycogen and acid mucopolysaccharides.

Roy *et al.* (1976) observed that in the goat, the follicular cells were PAS positive and showed the presence of glycogen, lipid, tyrosine, acid phosphatase and alkaline phosphatases. The cells showed negative reactions for calcium, iron, phospholipids and acid mucopolysaccharides.

Roy *et al.* (1978) observed that in the goat, the active follicles were lined with simple columnar or cuboidal epithelium whereas larger inactive ones with low cuboidal or simple squamous epithelium. Histochemically, the follicular cells were PAS positive and showed the presence of glycogen, lipid, tyrosine, acid phosphatase and alkaline phosphatases. The cells showed negative reactions for calcium, iron, phospholipids and acid mucopolysaccharides.

Banks (1981) stated that height of the cells within a given follicles remained uniform. Smaller follicles usually had a higher epithelium and were active.

Singh & Bharadwaj (1982) recorded that in male white leg horn chicken, the follicles were large and lined with a higher epithelium in all the age groups than in females. The zonal variations in the follicular epithelium from simple squamous to simple columnar indicated a functional heterogenicity of gland in both the sexes.

Prasad (1983) studied that the follicular epithelium varied from simple columnar to simple squamous type. A significant decrease in mean height was noticed with the increased of age in goat. Histochemically, the follicular cells contained PAS positive granules and were mucopolysaccharides.

Dellmann (1987) described that in domestic animals, the follicular epithelium assumed different shapes under various physiological conditions. When resting, cells were either low cuboidal or even squamous while when stimulated, the cells become cuboidal or columnar.

Atoji *et al.* (1999) described that the follicular epithelial cells of camel frequently showed apocrine secretions into colloidal lumens. Apocrine protusion with smooth surface were dome-like or baloon like structures and contained a fine granular matrix. These findings indicate that the morphological features of the follicular epithelial cells of the thyroid gland of camel are essentially similar to those of mammals except for the presence of apocrine secretions, which is unique to the camel.

2.B.b.b. Follicular colloid:

Trautmann and Fiebiger (1957) described that thyroid colloid in domestic animals was generally acidophilic while occasionally a varying degree of basophilia was also found.

Bloom and Fawcett (1962) mentioned that the follicular colloid in thyroid was composed of iodinated and non – iodinated proteins. A second group of protein in colloid was related to mucoprotein.

DesMarais and Lattam (1962) developed a new staining technique for the thyroid gland involving the use of two components of mallory connective tissue, stain, Aniline blue and orange G in reversed proportion various indices such as incorporation of I^{131}, Epithelial cell height and number of blue and yellow staining follicles and total number of follicles were used to test the validity of the colour reaction in the colloid. The colloid materials that stained with aniline blue corresponded to iodinated thyroglobulin while

the yellow staining materials appeared to be devoid of biologically active iodinated amino acid.

Copenhaver (1964) described that colloid in different glands or even in the follicle of a single gland may show tinctorial difference. In activated glands the colloid was predominantly basophilic but in inactive glands the colloid was acidophilic. Desquamated or phagocytic cells were present in the colloid.

Halmi (1966) mentioned that dense colloid was more acidophilic whereas the dilute one more basophilic. The colloid was intensely PAS positive due to large amount of glycoprotein, the thyroglobulin.

Seljelid (1967) found that when a section of normal gland of rat stained by PAS technique the follicular colloid gave a strong positive reaction.

Roy (1970) reported that in buffalo, the follicular colloid was PAS positive and showed mild positivity for glycogen and acid mucopolysaccharides. The smaller follicles contained more iodinated colloid than the larger ones.

Roy *et al.* (1976) recorded positive reaction for glycogen, lipid and tyrosine in the colloid of goat thyroid. They further reported the absence of calcium, iron and acid mucopolysaccharides in the colloid.

Banks (1981) described that in active follicles, the colloid had peripheral vacuoles and strong acidophilia. An inactive follicles it was slightly basophilic or eosinophilic with smooth peripheral margin.

Singh and Bharadwaj (1982) recorded that in white leghorn chicken the follicular colloid was PAS positive and showed only a weak reaction for glycogen and acid mucopolysaccharides.

Prasad (1983) studied the thyroid gland in the goat and found that a homogenous colloid filled the lumina of follicles. The density and staining intensity differed in different follicles even in the animals of same age group. In small and medium sized follicles, the colloid was in general thin and basophilic. Colloid was however, thick and acidophilic in larger follicles. Histochemically, the colloid was PAS positive and did not react for glycogen and acid mucopolysaccharides.

Dellmann (1987) mentioned that in domestic animals thyroidal colloid was PAS positive due to presence of glycoprotein.

Sathyamoorthy and Vijayragavan (1997) described that the colloid cells of Langendorff were noticed in the colloid of Japanese quail.

Mukherji *et al.* (1998) described that the colloidal material was more in the thyroid follicles of the female rats while few empty follicles were seen in the male thyroid.

Sonap *et al.* (1998) recorded that the colloid material was acidophilic and homogenous in intact animals which appeared shrunken and detached from the follicular wall in castrated animals.

2.B.c. Parafollicular Cells or 'C' Cells:

Various names have been given to the second cell type of the thyroid gland as 'C' cells or parafollicular cells or thyroid calcitonin cells or light cells.

Bloom and Fawcett (1962) described the occurrence of parafollicular cells both in the follicular epithelium and the interfollicular spaces of thyroid gland in human beings.

Halmi (1966) described that light cells were never in contact with follicular lumen and were rather sparse and lacked polarity which was found

in the follicular cells. These cells did not contain cytoplasmic colloids droplets.

Kameda (1968) identified the parafollicular cells of dog, cat, rabbit, rat, mouse and guinea pig by Davenport Silver impregnation method.

Roy and Yadav (1973) described that the thyroid gland of buffaloes. Light cells were seen in among the colloid droplets, laden follicular cells. The constituted a second epithelial component of the thyroid gland. The light cells had a large nucleus with faintly stained cytoplasm and occurred singly or in a group of 2 or 3 cells. They were devoid of uniform contour and were located among the follicular cells or in between these cells and basement membrane. Light cells were positive for protein and negative for PAS, protein bound NH_2, lipid and glycogen.

Roy and Yadav (1975) observed that in buffalo thyroid, the lightly stained parafollicular cells were argyrophilic in nature.

Nalavade *et al.* (1976) reported that thyroid C cells in lizard were reactive for neutral mucosubstances and sulphomucins.

Tice (1977) described that C cells of human thyroid stained well with silver probably due to their catecholamine content.

Banks (1981) described that parafollicular cells in domestic animals contained pale staining cytoplasm. They were distributed in parafollicular position or within the lining epithelium of follicles where in they occasionally reached the laminal surface.

Srivastava and Swarup (1982) reported that in fox the C cells were round, oval or elongated in shape. They were distributed unevenly with in the follicular epithelium or in few cases in the interfollicular spaces. The C cells showed mild PAS reactivity.

Singh and Bharadwaj (1982) observed the parafollicular cells at the periphery or in between the follicular cells in case of white leg horn chicken.

Prasad (1983) reported that in goat, C cells were round to oval. The cytoplasm was lightly stained containing fine refractive granules. The nuclei were vesicular and larger in size than those of the follicular cells. According to their distribution, the cells were identified as intrafollicular, parafollicular and interfollicular C cells. The cytoplasmic argyrophilia was recorded in these cells. The intrafollicular cells were negative for glycogen and acid mucopolysaccharides.

Roy *et al.* (1983) reported in the goat that the parafollicular cells were negative for PAS reaction. However, these cells showed positive reactions for lipid, protein and acid phosphatase.

Dellmann (1987) stated that parafollicular cells were identified by their light stained cytoplasm. They occurred singly within the basement membrane of the follicles. In few animals, particularly in dog, these cells were distributed in groups within or outside the follicles.

Okada *et al.* (1990) described that in sheep the parafollicular cells were limited to the upper two third of the thyroid.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

Twelve adult rabbits, 6 male and 6 female were taken into account during present investigations. The tissue samples were collected from adrenal and thyroid glands.

Source of animals :

Healthy animals were procurred locally and maintained by the Department of Veterinary Anatomy & Histology, Bihar Veterinary College, Patna under proper hygienic and management conditions.

Collection and Preservation of tissues :

The endocrine tissues viz., adrenal and thyroid were collected immediately after humane sacrifice. The tissues thus collected were cut into small pieces and were preserved in various fixatives to ensure different types of staining schedules for histology and histochemistry.

The following fixatives were used (Luna, 1968)

(i) 10% neutral buffered formalin

(ii) formal – sublimate

(iii) Zenker's fluid

(iv) Bouin's fluid

(v) Chilled 80% alcohol

(vi) Orth's fluid

Embedding :

Paraffin embedding was carried out for the tissues after proper washing, dehydration, clearing and infiltration (Luna, 1968). The tissues, fixed in chilled 80% alcohol, were processed in refrigerator and embedding was done in paraffin wax having 52^0C congealing point (Humason, 1967).

Microtomy :

Paraffin sections were cut at 5-7μm with the help of rotary microtome and mounted on slides. Frozen sections from formalin fixed tissues were cut at 10 – 15 μm for lipid staining with oil red 'O'.

Histological and Histochemical staining :

To study various histological and histochemical details, the following staining methods were employed.

Histological staining procedures :

(i) Haematoxylin – eosin stain (Luna, 1968) – for routine study.

(ii) Modified Mallory's trichome stain (Crossman, 1937) – for connective tissue fibers.

(iii) Van Gieson's stain (Drury and Wallington, 1967) – for collagen fibers.

(iv) Gomori's reticulin stain (Drury and Wallington, 1967) – for reticular fibers.

(v) Verhoeff's elastic stain (Pearse, 1968) – for elastic fibers.

Histochemical staining procedures :

(a). Stains for Carbohydrates :

(i) McManus PAS reaction with and without saliva digestion (Luna, 1968) for glycogen and neutral mucosubstances.

(ii) Modification of Mowry's 1958 colloidal iron stain for acid mucopolysaccharides.

(b). Stain for nucleic acid :

(i) Feulgen reaction (Pearse, 1968) for DNA.

(C). Stain for alkaline phosphatase enzyme :

(i) Gomori's calcium cobalt method (Pearse, 1968) for alkaline phosphatase.

(d). Stains for lipids :

(i) Oil red 'O' method (Pearse, 1968) for neutral fat.

(ii) Sudan black B staining for lipids in paraffin sections (Pearse, 1968).

(f). Stain for vitamin :

(i) Silver method, after Jensen and Kavalijan (Pearse, 1968) for ascorbic acid.

Special staining procedures :

(a) Demonstration of epinephrine and nor-epinephrine containing cells in adrenal medulla. Eosin – aniline blue method (Wood, 1963).

(b) Demonstration of iodinated and non – iodinated colloid in thyroid. Modified aniline blue – orange G. stain (DesMarais and Lattam, 1962).

(c) Demonstration of chromaffin cells in adrenal medulla. Giemsa staining after dichromate fixation (Pearse 1968).

Micrometry :

Measurements of various structures were made with the help of caliberated ocular micrometer.

Number of thyroid follicles were calculated at per mm^2 area after standardizing the diameter of field areas with the help of stage micrometer.

Statistical analysis :

Mean, Standard error (S.E.), Analysis of variance (ANOVA) and Critical difference test (C. D. test) were calculated on different data for statistical interpretations (Snedecor and Cochran, 1967).

RESULTS AND DISCUSSION

4. RESULTS AND DISCUSSION

4.A. Adrenal gland :

Histomorphologically the adrenal gland contained a central medulla and peripheral cortex and was encapsulated by a thin connective tissue capsule from outside. Similar distribution of adrenal medulla and the cortex were described by various authors in different domestic animals (Sohal and Chaturvedi, 1962; Roy, 1970; Banks, 1981 and Dellmann, 1987).

4.A.a. Capsule and Stroma :

The thin capsule of adrenal gland in rabbit was predominantly made up of collagen fibers with scanty distribution of reticular fibers. The elastic fibers were lacking (Fig. – 1). The smooth muscle cells were seldom found in the capsule. The juxta-cortical part of the capsule appeared more cellular, predominated with the distribution of fibroblasts (Fig. – 3). Apart from distribution of blood vessels and lymph spaces in the capsule, the cortical cell clusters in the form of spherical or oval nodules were occasionally found in both sexes (Fig. – 2). From the inner margin of the capsule, the connective tissue fibers descended into the gland to constitute stromal network. The observations thus made on the adrenal capsule of the rabbit could be compared with the descriptions made by Trautmann & Fiebiger (1957) in domestic animals, Sohal & Chaturvedi (1962) in buffalo, Greep and Deane (1966) in mammals, Roy (1970) in buffalo and Banks (1981) and Dellmann (1987) in domestic animals. However, presence of few elastic fibers was described in the capsule of adrenal glands in domestic animals by Trautmann & Fiebiger (1957). Delphia *et al.* (1959) in cattle, Roy (1970) in buffalo and Dellmann (1987) in domestic animals, reported cortical cell clusters in the

capsule of adrenal glands. Similar cortical cell clusters were also observed in the adrenal capsule of rabbit.

The average thickness of the capsule in male rabbit measured 17.3 ± 0.121 μm while in female 16.9 ± 0.098 μm. The statistical analysis revealed that the average thickness of adrenal capsule in male rabbit was 0.4 μm higher than in the female one which differed significantly ($P<0.05$) between the two sexes (Table No. – 1). Prasad and Sinha (1981[C]) reported thicker adrenal capsule in male than female in case of sheep, goat and pig while in case of horse and dog the capsule was thicker in female.

Stromal network of the gland was formed by fine collagen and reticular fibers in the cortical area. These fibers descended through cortical area from the juxta-cortical margin of the capsule. Near the corticomedullary junction, the stromal fibers terminated and condensed.

These stromal fibers surrounded the cell cords or cell clusters of the adrenal cortex. The stromal network was most prominent at the cortical part near corticomedullary junction (Figs.- 2, 3, 4, 5, 6, 8). The stromal framework in the adrenal medulla was made up of collagen fibers in association with conspicuous fibroblasts. It appeared that the stromal fibers of cortex normally failed to extend in the medulla. Although, the cortical tissues extended into the medulla were surrounded by extended stromal fibers of the cortex. The present observations on the stromal network of rabbit's adrenal were in agreement with the description of Dellmann (1987) who mentioned that a thin trabeculae originating from the capsule penetrated the cortex which rarely entered into the medulla of adrenal gland of domestic animals.

Histochemically, the adrenal capsule of rabbit was negative for glycogen, neutral mucopolysaccharides, glycoprotein, acid mucopolysaccharides, lipids, ascorbic acid and alkaline phosphatase. However the blood vessels present in the capsule or in the stroma occasionally showed mild positivity for alkaline phosphatase at the endothelial margin. The stromal fibers of the gland also reacted like that of the capsule. The findings of the rabbit's adrenal capsule and stroma were incontrast to the findings of the Zimny (1959) who reported positive reaction for PAS in the capsule of adrenal gland in the ground squirrel. Roy (1970) also reported PAS positive capsule in the adrenal gland of buffalo. He however observed little amount of fat in the capsule as well. Prasad and Sinha (1981[b]) who reported positive reaction for PAS, glycogen and acid mucopolysaccharides in the capsule of adrenal gland in buffalo, horse, dog, goat, sheep and pig.

4.A.b. Adrenal Cortex:

The cells of the adrenal cortex of rabbit exhibited varying histomorphological characters. According to these characters, three different cell types viz. zona glomerculosa cells, zona fasciculata cells and zona reticularis cells were identified in male and female rabbit's adrenal cortex. The zona glomerulosa cells were arranged in spherules or hemi-spherules to constitute zona glomerulosa at sub-capsular part of cortex (Fig.-2). The zona fasciculata cells were arranged in long cords separated by sinusoids and were interposed between the zona glomerulosa cells peripheraly and zona reticularis cells centrally. The fascicular arrangement of these cells formed the zona fasciculata (Figs.-1,2). The zona reticularis cells were distributed at the deepest part of the cortex, arranged in irregularly anastomosing cell cords

which constituted the zona reticularis (Fig.– 6). Since there was absence of a distinct line of demarcation between the zones formed by zona fasciculata and zona reticularis cells, the remaining part of the cortex other than sub capsular zona glomerulosa had been considered together as zona fasciculata-reticularis.

The thickness of adrenal cortex in male rabbit (1221.16 ± 1.96μm) was significantly higher than in female rabbit (1177.28 ± 5.107μm) as shown in Table No.-1.

The zona intermedia was not found in the adrenal cortex either in male or in female rabbit. Although Carter and Lever (1954) in mammals, Sohal and Chaturvedi (1962) in buffalo, Das *et al.* (1965) in bull, Yamauchi (1965) in aged Cow and Dellmann (1987) in some domestic animals reported the presence of zona intermedia between the zona glomerulosa and zona fasciculata of adrenal cortex. Prasad (1978), however reported the absence of this zone in the adrenal cortex of sheep, goat and pig.

4.A.b. a. Zona glomerulosa :

The average thickness of zona glomerulosa was measured as 107.2 ± 0.12 μm in male whereas 99.6 ± 0.88 μm female rabbit. The statistical analysis revealed that the male zona glomerulosa was 7.6 μm thicker than the female which showed significant difference at 5% level (Table No. – 1).

The cells of zona glomerulosa were surrounded by fine reticular and collagen fibers. The central core of spherule contained sinusoid. The zona glomerulosa cells were pyramidal or low columnar in shape. The cell cytoplasm appeared eosinophilic and vacuolated. The apical border of each cell was in close proximity with centrally located sinusoidal wall. The round or oval nuclei usually presented basophilic chromatin materials dispersed

peripheraly. A prominent nucleolus was usually found in the nucleus paracentrally. The morphological character of zona glomerulosa cells of rabbit could be compared with columnar cells of zona glomerulosa in bull (Cupps *et al.* 1954), spherical or oval in buffalo (Sohal & Chaturvedi, 1962) and polyhedral in ruminants (Banks, 1981). Yamauchi (1961) and Dellmann (1987) also described acidophilic cytoplasm in the cells of zona glomerulosa of bovine adrenal cortex. Yamauchi (1961) further considered that these acidophilic granules were associated with the normal endocrine activities of the cells. The nuclear basophilia as observed in the case of rabbit's zona glomerulosa cells were not in agreement with Cupps *et al.* (1954) who observed vesicular nucleus in normal bull. Similarly Banks (1981) also described less darker nucleus in the cells of zona glomerulosa than the cells of adjacent zone in domestic animals. Histochemically, the cells of zona glomerulosa in rabbits did not react for glycogen, glycoprotein and neutral mucopolysaccharides with PAS reaction. These cells were also negative for acid mucopolysaccharides and alkaline phosphatase. Mild to moderate positivity for lipids and ascorbic acid were recorded in these cells. The nuclei were moderately reactive for DNA when stained with Feulgen technique. No apparent variations of these reaction were noticed between the two sexes of rabbit (Table No. – 2).

Absence of glycogen in the zona glomerulosa cells of the rabbit was in conformity with the finding of Girod (1960^{b}) who also recorded absence of glycogen in these cells of rabbit both in normal state and the state following submission to various endocrine influences. Planel *et al.* (1960) however, observed glycogen in these cells in several animals including rabbit. The negative reaction for neutral mucopolysaccharides, glycoprotein and acid

mucopolysaccharides in these cells of rabbit did not agree with the findings of Roy (1970) who recorded mild reaction for PAS and acid mucopolysaccharides in the glomerulosa cells of buffalo adrenal cortex. Prasad and Sinha (1981[b]) also reported negative reaction for PAS positive substances and glycogen in the zona glomerulosa cells of different domestic animals including buffalo.

The lipid accumulation and ascorbic acid reaction in the zona glomerulosa cells of rabbit could be well compared with Nickerson (1971) who observed sparse lipid droplets in these cells of Mongolian gerbil. Prasad and Sinha (1981[b]) also recorded weak reaction for lipid droplets in these cells in different domestic animals except in dog where the reaction was weak to moderate. The inter-relationship between the concentration of lipid and ascorbic acid could be associated with the functional status of these cells as opined by Gorbman & Bern (1962) in mammals and Ganguli & Ahsan (1978) in goat.

The absence of alkaline phosphatase in the glomerulosa cells of rabbit adrenal cortex was in agreement with the findings of Roy (1970) in buffalo adrenal glands.

4.A.b.b-c. Zona fasciculata – reticularis :

The average thickness of zona fasciculata – reticularis in male rabbit was 1096.66 ± 1.99 μm whereas in female it was 1060.78 ± 4.879 μm. The mean thickness of this combined zone was 35.88 μm greater in male than in the female rabbits. The statistical analysis revealed the significant ($P<0.05$) difference between the combined thickness of zona fasciculata – reticularis of male and the female rabbits (Table No. – 1). Girod (1960[a]) also recorded sexual dimorphism in the rabbit's adrenal gland histologically. He further

opined that such sexual dimorphism affected the internal zone of adrenal cortex. The absence of clear line of demarcation between classically described zona fasciculata & zona reticularis in the adrenal cortex of rabbit was in full agreement with the finding of Yamauchi (1965) who did not find the sharpline demarcation between these two zones in the adrenal cortex of heifer and cow. He further reported that the combined thickness of two zones increased with age.

4.A.b. b-c.(i) Zona fasciculata Cells :

The zona fasciculata cells appeared as polyhedral or oval in shape. The cytoplasm was faintly acidophilic and granular showing few vacuoles. The vesicular nucleus was usually spherical (Fig. – 4). Binucleated cells were absent. The zona fasciculata cells arranged in radial columns and cords separated by sinusoids (Figs. – 4, 5, 6). With Giemsa stain, the cytoplasm appeared bluish in colour (Fig. – 5). The histological details of zona fasciculata cells in rabbit's adrenal cortex could be well compared with the fasciculata cells of bull (Cupps *et al.*, 1954), in domestic animals (Trautmann & Fiebiger, 1957), in buffalo (Sohal and Chaturvedi, 1962 and Roy, 1970) and in domestic animals (Banks, 1981 and Dellmann, 1987).

Histochemically, the zona fasciculata cells of rabbit adrenal cortex were negative for PAS, glycogen and acid mucopolysaccharides. The cells of peripheral zone were moderately reactive for lipid droplets. The cells of deeper zone were intensely reactive, when stained with oil red '0'. However, with Sudan black B the positive reaction for lipid was moderate throughout (Figs.- 18, 19). The positive reaction for ascorbic acid varied from mild to moderate degree in these cells (Figs.- 16, 17). The zona fasciculata cells were negative for alkaline phosphatase and their nuclei were mildly reactive

for DNA The negative reactions for glycogen and PAS in the zona fasciculata cells of rabbit did not agree with Roy (1970) and Prasad & Sinha (1981[b]) where they recorded PAS positivity and presence of glycogen in zona fasciculata cells of buffalo and bullock. Prasad and Sinha (1981[b]) however recorded negative reaction for PAS and glycogen in zona fasciculata cells of horse, dog, goat & pig.

The lipid accumulation of zona fasciculata cells of rabbit could be correlated with the findings of Roy (1970) in buffalo, Nickerson (1971) in Mongolian gerbil, Prasad and Sinha (1981[b]) in domestic animals and Varadaraju & Roa (1982) in Indian mangoose. The variation in the concentration of lipid accumulation in relation with ascorbic acid might be showing the functional status of zona fasciculata cells. Although, Bell and Weber (1959) reported lesser tendency for lipid accumulations in these cells of heifer and cow. Iskander & Mikhail (1966) also reported lipid rich outer part of zona fasciculata in camel's adrenal gland. The Feulgen reactivity of the nuclei of these cells of rabbit was in agreement with the findings of Roy (1970) in buffalo Prasad & Sinha (1981[b]) also observed moderate to strong positivity for DNA in the nucleus of zona fasciculata cells in different domestic animals.

4.A.b. b-c.(ii) Zona reticularis Cells :

Zona reticularis cells were arranged in irregularly anastomosing cell cords at the deepest part of the adrenal cortex of the rabbit (Figs.– 4,6,7,8,9). These cells were comparatively smaller than the zona fasciculata cells and were surrounded by distinct connective tissue fibers. These connective tissue fibers appeared more pronounced around these cells near corticomedullary junction. At several points, the zona reticularis cell cords intruded in the

medulla obliquely or in curved manner (Figs. – 8, 9, 10). Therefore, these cells appeared as small clusters in the medulla at several places. Roy (1970) also observed isolated cell clusters of cortical tissues in the pheripheral zone of adrenal medulla in buffalo.

The zona reticularis cells appeared oval or polyhedral in outline showing distinct cell boundries. The cells cytoplasm was acidophilic and granular with the basophilic nucleus having oval or round outline. With Giemsa stain, the cytoplasm appeared lightly purple in colour (Fig. – 7). Few of the cells near corticomedullary junction, appeared agranular and vacuolated with the vesicular nucleus. The majority of the cells at this region were intensely acidophilic having hyperchromatic nucleus. The present observations on the histological characters of zona reticularis cells could be compared with the observations made by Cupps *et al.* (1954) in bull, Trautmann and Fiebiger (1957) in domestic animals, Sohal and Chaturvedi (1962) in buffalo, Banks (1981) and Dellmann (1987) in domestic animals. Roy (1970) also observed 'light' and 'dark' zona reticularis cells at the deepest zone of adrenal cortex of buffalo.

The cytoplasm of zona reticularis cells of rabbit's adrenal was negative for glyco protein, glycogen, acid mucopolysaccharides and alkaline phosphatase. The cytoplasm was however mild to moderately reactive for lipids and mildly reactive for ascorbic acid (Figs.- 16, 18, 20). These cells were having mildly Feulgen - reactive nucleus. The present observations were not in agreement with the finding of Prasad & Sinha (1981[b]) who recorded the presence of PAS positive substances and glycogen in the zona reticularis cells of different domestic animals. Nickerson (1971) recorded sparse lipid droplets in the reticularis cells of Mongolian gerbil. Prasad and

Sinha (1981[b]) however reported weak positivity for lipids in this zone in case of bullock and dog. The lipid droplets were absent in sheep, goat and pig whereas the cells of this zone in case of she buffalo, bullock and horse presented negative to weak reaction for lipids.

4.A.c. Adrenal Medulla:

The adrenal medulla of rabbit occupied the central part of the organ surrounded by peripherally organised cortical tissues (Figs.- 8, 9). The cells were arranged in cell cords or cell clusters in the form of small follicles and were separated from each other by prominent sinusoidal network (Fig. 10). At the centre of the adrenal medulla wide lumened veins were observed. No ganglion cell was observed in the medulla of rabbit. The cells were closely surrounded by prominent connective tissue meshwork of collagen fibers in association with fibroblasts (Figs.- 10, 11). The adrenal medullary cells of rabbit were oval or columnar in shape. The cytoplasm appeared coarsely granular. These granules were weakly basophilic with Haematoxylin and Eosin stain. In dichromate fixed section these cytoplasmic granules appeared lightly orange in colour when stain with modified Crossman's trichome method. The large vesicular nucleus appeared oval or spherical in outline. Usually prominent nucleolus was present in the nucleus. Within the population of adrenal medullary cells, the cortical cell clusters comprised of zona reticularis cells were distributed (Figs. – 8, 9, 10). The present observations were inconformity with the descriptions of Trautmann and Fiebiger (1957) in domestic animals, Sohal & Chaturvedi (1962) in buffalo, Smollich (1965) in ruminants, Greep and Deane (1966) in man, Banks (1981), Prasad and Sinha (1981[a]) and Dellmann (1987) in domestic animals. The present observations were also in agreement with Akolaker and Agrawal (1976) who also reported frequent distribution of cortical tissues in the

adrenal medulla of goat. With eosin – aniline blue stain as suggested by Wood (1963), the cells of adrenal medulla appeared brownish purple in colour which was suggestive for epinephrine containing cytoplasm of the particular cells (Figs. – 14, 15). The presence of only adrenaline containing cells was further confirmed with Giemsa stain where epinephrine-containing cells appeared dark. The norepinephrine containing cells having darker green cytoplasm could not be observed (Figs. – 13, 14). This was in conformity with the finding of Wood (1963) who also recorded the presence of only epinephrine containing cells in the adrenal medulla of rabbit. However Coupland *et al.* (1964) in various domestic animals, Smollich (1966) in most ruminants, Zamora *et al.* (1967) in calves, Roy (1970) in buffalo, Prasad and Sinha (1981[a]) in different domestic animals and Baishya *et al.* (1988) in mithun and yak recorded two distinct zone of adrenal medulla comprised of epinephrine and nor epinephrine containing cells in different zones.

The cells of adrenal medulla were negative for PAS positive substances, acid mucopolysaccharides, lipid droplets, ascorbic acid and alkaline phosphatase. The vesicular nucleus was mild to moderately positive for DNA. Roy (1970) reported mild positivity for PAS, moderate for acid mucopolysaccharides and mild for nuclear DNA in the adrenal medulla of buffaloes. He however, could not observe lipid droplets and alkaline phosphatase in the medullary cells. Prasad and Sinha (1981[b]) also reported variable positivity for PAS and glycogen in the adrenal medullary cells of different domestic animals. They however observed moderate to strong positivity for acid mucopolysaccharides, mild to moderate for nucleic acid and negative reactions for lipid droplets in these cells of different domestic animals.

TABLE – 1

Mean ± S.E. along with C. V. % of thickness (μm) of capsule and different cellular zones of cortex in adrenal gland of rabbits.

Structures		Mean ± S.E.	C.V. %
Adrenal Capsule	Male	$17.3^{a} \pm 0.121$	0.016
	Female	$16.9^{b} \pm 0.098$	0.01
Zona Glomerulosa	Male	$107.2^{a} \pm 0.12$	2.52
	Female	$99.6^{b} \pm 0.88$	0.019
Zona Fasciculata + Zona Reticularis	Male	$1096.66^{a} \pm 1.99$	4.07
	Female	$1060.78^{b} \pm 4.879$	0.01
Total Cortex + Capsule	Male	$1221.16^{a} \pm 1.96$	3.60
	Female	$1177.28^{b} \pm 5.107$	9.717

Means with different superscripts differ for each trait significantly ($P<0.05$).

TABLE – 2.

Showing certain histochemical properties in the adrenal gland of rabbit.

Structures	PAS with and without saliva digestion		Colloidal iron	Oil red 'O' stain	Sudan black 'B' stain	Silver method	Gomori's calcium cobalt method	Feulgen reaction
	Mucopolysacc-harides	Glycogen	Acid Mucopolysaccharides	Neutral fat	Lipids	Ascorbic acid	Alkaline phosphatase	DNA (in nucleus)
Capsule & Stroma	–	–	–	–	–	–	–	N.R.
Endothelium of blood vessels	–	–	–	–	–	–	+	+
Zona glomerulosa cells	–	–	–	+ to + +	+ to + +	+ to + +	–	+ +
Zona fasciculata cells	–	–	–	+ + to + + +	+ +	+ to + +	–	+
Zona reticularis cells	–	–	–	+ to + +	+ to + +	+	–	+
Adrenal medulla	–	–	–	–	–	–	–	+ to + +

– = Negative + = weak ++ = Moderate +++ = Intense reaction N.R. Not recorded

4.B. Thyroid gland :

Like other mammals, thyroid gland of rabbit was comprised of two thyroid lobes and isthmus. The thyroid lobes were situated on the respective lateral sides of first two or three tracheal rings whereas the long isthmus connected the caudal end of two lobes after crossing the corresponding sides and making on U-shaped curve near fourth or fifth tracheal rings.

4.B.a. Capsule and Stroma:

The thyroid gland of rabbit was covered by a capsule made up of irregular connective tissue. The proper capsule was surrounded peripheraly by loose connective tissue which was derived from peritracheal fascia (Fig.- 21). The proper capsule was perdominated with the distribution of collagen fibers with occasional presence of fine reticular fibers. The histological structures of capsule could be well correlated with the descriptions made on the thyroid capsule by Trautmann & Fiebiger (1957) in domestic animals, Bloom and Fawcett (1962) in mammals, Das *et al.* (1965) in bull and bullock, Roy *et al.* (1978) and Prasad (1983) in goat, Talukdar and Bordolai (1996) in Rhino calf, Sathyamoorthy (1997) in Japanese quail and Breit *et al.* (1998) in birds. Das *et al.* (1965) additionally reported the presence of smooth muscle fibers along with collagen and reticular fibers in the thyroid capsule of bull & bullock. The smooth muscle fibers could not be observed in the capsule of rabbit's thyroid.

The stroma of the thyroid gland in rabbit was formed by loose connective tissue dividing each lobe into various lobule-like structures (Figs.-21, 22, 23, 24). Apart from loosely distributed connective tissue fibers, the stroma was rich in blood vessels and nerve fibers. The perifollicular capillary network was quite prominent. Trautmann & Fiebiger

(1957) also described that interfollicular fat-free connective tissue stroma in the thyroid gland of domestic animals was delicate and well vascularized. The follicles were closely surrounded by reticular meshwork. Talukdar and Bordolai (1996) observed that the connective tissue trabeculae from the capsule of thyroid gland in Rhino calf divided the glandular tissues in lobes, lobules and follicles.

Histochemically, the thyroid capsule and stroma of rabbit were negative for PAS reaction, acid mucopolysaccharides, lipids, ascorbic acid and alkaline phosphatase. The nucleus of connective tissue cells however reacted mild to moderately for D N A (Table No.- 4). The luminal margin of the blood vessels present in the capsule as well as in the stroma showed mild positivity for alkaline phosphatase. The present observations did not tally with the findings of Roy (1970) and Prasad (1983) who observed PAS positivity in the capsule and stroma of thyroid gland in buffalo and goat respectively. Prasad (1983) further recorded negative reaction for glycogen and acid mucopolysaccharides in these components of goat's thyroid gland.

4.B.b. Thyroid follicles:

The thyroid follicles of rabbit were distributed throughout the thyroid lobe in the small groups or clusters, separated by loosely distributed stromal tissues. The follicular shape varied from small spherical to large oval in outline. Some of the follicles appeared tubular or sacculated (Figs.- 21, 22, 23, 24, 25, 26). The distribution of larger and smaller follicles did not show definite pattern in respect to superficial and deeper part of the lobe. In case of male rabbit the follicular population was recorded as 180.5 ± 2.45 per mm^2 area, whereas in female the follicular population remained 180.63 ± 6.108 per mm^2 area. Statistically the difference was non significant at 5%

level (Table No.- 3). Trautmann and Fiebiger (1957) in domestic animals, Tomonari (1959) in several domestic animals including rabbit, Copenhaver (1965) in man and Das *et al.* (1965) in bull and bullock also recorded different shape of the thyroid follicles. Roy (1970) however reported that most of the follicles were oval in shape in the thyroid lobe of buffalo. He further reported that the larger follicles were predominantly present in the deeper part of the lobe.

The observations made on rabbit tallied with the findings of Roy *et al.* (1978) and Prasad (1983) in goat, Sathyamoorthy and Vijayragvan (1997) in Japanese quail and Mukherji *et al.* (1998) in rat, who observed round or spheroid and oval thyroid follicles. Briet *et al.* (1998) observed ovale thyroid follicles in case of birds with a pyramidal top on each end of such follicles. Sonap *et al.* (1998) however, recorded variation of the thyroid follicular shape in prepubertal and pubertal cattle. They further reported larger elongated follicles in the thyroid gland of castrated animals.

4.B.b.c. Follicular epithelium:

The most of the thyroid follicles were lined with simple cuboidal epithelium. However extremely larger follicles presented simple squamous epithelial lining (Figs.- 25, 26, 27, 28, 29). The cuboidal epithelial cells showed clear cell boundries and terminal bars (Fig.- 28). The cytoplasm appeared finely granular and acidophilic. The nucleus was oval or round and was usually placed parabasally. In simple squamous epithelium the flattend cell presented hyperchromatic flattened nucleus (Fig.- 29). The height of epithelium in male rabbit varied between 8.9µm to 14.28µm with an average height of 10.44 ± 1.99µm. In females, the epithelial height ranged from 5.69µm to 13.45 µm with an average height of 9.85 ± 0.24 µm. The variation

in the height of the follicular epithelium could be correlated with the functional status of thyroid follicles. Tomonari (1959) in different domestic animals including rabbit also recorded that during non active stage the larger follicles presented flattened epithelium. Similar observations were also made by Mukherjee *et al.* (1960) in the thyroid gland of goat and ram during different seasons. Copenhaver (1964) in man, Das *et al.* (1965) in bull & bullock, Roy (1970) in buffalo, Roy *et al.* (1978) in goat, Banks (1981) in domestic animals, Singh and Bharadwaj (1982) in white leghorn chicken and Dellmann (1987) in domestic animals also reported variation of follicular epithelium with particular reference to its height during different physiological conditions of the gland. Atoji *et al.* (1999) observed the follicular cells of thyroid gland in camel sub microscopically and reported apocrine type of secretory behaviour of these cells.

Histochemically intracellular PAS positive granules could not be observed in the cells of simple squamous epithelium. Although occasional mild reaction for PAS was observed at the supranuclear cytoplasm of cuboidal follicular cells. In general, the follicular cells were negative for glycogen, acid mucopolysaccharides, alkaline phosphatase, ascorbic acid and lipids (Table No. – 4). The present histochemical observations in respect to PAS positivity were inconformity to the finding of Roy (1970), Roy and Yadav (1975) in buffalo, Roy *et al.* (1976) and Prasad (1983) in goat Roy and Yadav (1975) however reported presence of glycogen and acid mucopolysaccharides in the follicular cells of buffalo thyroid. Similarly Roy *et al.* (1976) observed the presence of glycogen., lipid and alkaline phosphatase and absence of acid mucopolysaccharides in the follicular cells of thyroid gland in goat.

The nuclei of follicular cells in rabbit's thyroid reacted moderately for Feulgen reaction suggesting the presence of DNA (Figs.- 34, 35). Roy (1970) also reported moderate Feulgen reaction in the follicular cell of buffalo thyroid.

4.B.b.b. Follicular Colloid:

Most of the follicles of rabbit's thyroid contained eosinophilic colloidal mass. Some of the follicles appeared empty both in male and female rabbits. Occasionally, a few desquamated cells of follicular epithelium appeared in the colloid. The peripheral margin of the colloid facing the apical border of follicular cuboidal epithelium appeared wavy. Occasionally, the colloid presented large vacuoles paracentrally (Figs.- 21, 22, 23, 24, 25, 26). In some of the follicles, the colloid appeared to be very thin and was fibrinous (Fig.- 27). Apart from eosinophilic character of the colloid variable shades of basophilia were also recorded. The present findings on the follicular colloid in rabbit's thyroid could be compared with the descriptions made by Trautmann & Fiebiger (1957) in domestic animals. Copenhaver (1964) described the presence of desquamated cells in the colloid of human thyroid. Sathyamoorthy and Vijayragavan (1997) also reported similar desquamated cells in the follicular colloid of Japanese quail.

The variations in staining character of colloid in rabbit might be elaborating the physiological status of the gland. Copenhaver (1964) in man reported that the colloid of activated gland appeared basophilic and the non-activated one the acidophilic. At the same time Banks (1981) described that in the active follicles colloid showed peripheral vacuoles with strong acidophilic staining capability whereas in inactive follicle the colloid was slightly basophilic or eosinophilic with smooth peripheral margin. Halmi

(1966) in man & Prasad (1983) in goat reported that the dense colloid appeared acidophilic whereas dilute one basophilic.

Absence of colloid in some of the follicles of rabbit's thyroid might be either due to functional inertia of the follicular cells or due to transfer of colloid from that segment of the follicles to the neighbouring segment at the time of fixation of the tissues. Mukherji *et al.* (1998) recorded few empty follicles in the thyroid gland of male rat only. Sonap *et al.* (1998) reported the effect of castration upon the status of colloid in cattle. They observed homogenous acidophilic colloid in intact animals whereas shrunken and detached in castrated animals.

Histochemically, the colloid was strongly PAS reactive (Fig.-33). The PAS positivity did not reveal the presence of glycogen when the section was passed through saliva digestion. The colloid was also negative for acid mucopolysaccharides, lipids, ascorbic acid and alkaline phosphatase (Table No.-4). The strong PAS positivity of colloid was due to the presence of glycoprotein. Halmi (1966) in man, seljelid (1967) in rat,Roy (1970) in buffalo, Singh and Bharadwaj (1982) in white leghorn chicken, Prasad (1983) in domestic animals also reported positive reaction for PAS in the follicular colloid of thyroid gland. In contrast to the present findings presence of glycogen and lipid in the thyroid colloid of goat had been reported by Roy *et al.* (1976). Singh & Bharadwaj (1982) also reported weak reaction for glycogen and acid mucopolysaccharides in the follicular colloid of white leg horn chicken. The present observation agreed with the finding of Prasad (1983) who reported that PAS positive follicular colloid of goat's thyroid did not react for glycogen and acid mucopolysaccharides.

With special stain as advised by DesMarias and Lattam (1962) the colloidal mass in each of the animal stained either orange or blue. Rarely a few follicles contained the admixture of orange and blue colloidal material. The blue colloid was suggestive for iodinated colloid whereas the orange for non-iodinated colloid (Figs.- 31,32). The generalized distribution of blue or orange colloid suggested that the iodination of colloid usually took place in almost all the follicles of an individual rabbit simultaneously. Bloom and Fawcett (1962) described in man that follicular colloid was composed of iodinated and non-iodinated proteins. The second group of protein was related to mucoprotein. In contrast to the present findings Roy (1970) recorded both iodinated and non iodinated colloid in the same section of the thyroid tissues. He however observed that the smaller follicles contained more iodinated colloid than the larger one.

4.B.c. Parafollicular cells:

The parafollicular cells were usually distributed within the cell clusters of interfollicular areas, occasionally few parafollicular cells in the basal zone of follicular epithelium. The parafollicular cells located at the interfollicular area presented lights coloured cytoplasm showing mild argyrophilia. The nucleus was oval or round and hyperchromatic (Figs.- 25, 26, 28). The parafollicular cells did not reach to the luminal margin of follicular epithelium. The hyperchromatic nucleus was oval in outline.

Distribution pattern of parafollicular cells in the thyroid gland of rabbit was in agreement with the views of Bloom and Fawcett (1962) in human beings, Banks (1981) in domestic animals, Singh and Bharadwaj (1982) in white leghorn chicken, Srivastava and Swarup (1982) in fox,

Dellmann (1987) in dog. Prasad (1983) reported three varieties of these cells as intrafollicular parafollicular & interfollicular C cells in goat.

In rabbit, the parafollicular cells did not show regional distribution in a particular lobe. Okada (1990) however observed in sheep that the parafollicular cells were limited to the upper two – third of the thyroid.

The mild argyrophilia of parafollicular cells in these animals was in agreement with Kameda (1968) in several animals including rabbit, Roy and Yadav (1975) in buffalo, Tice (1977) in man and Prasad (1983) in goat who also reported varying degree of affinity in these cells for Silver stain. Tice (1977) opined that the Silver positivity of these cells was probably due to their catecholamine content.

Absence of PAS positive material in these cells of rabbit could be considered to be in agreement with Halmi (1966) who described the absence of cytoplasmic colloid droplets in these cells of human thyroid. Nalavade *et al.* (1976) however reported the positive reaction for neutral mucosubstances and sulphomucin in the thyroid C-cells of lizard. The PAS negativity of parafollicular cells of rabbit was in agreement with the findings of Roy and Yadav (1973) in buffalo, Prasad (1983) and Roy *et al.* (1983) in goat. Although parafollicular cells were reported to the mildly PAS positive in the thyroid gland of fox (Srivastava and Swarup, 1982).

4.B.d. Isthmus:

The narrow long isthmus of rabbit's thyroid presented quite a few number of follicles covered by loose connective tissue (Fig.- 30). The follicular outline was usually irregularly oval. Histological character of follicular epithelium remained like those of the follicles of thyroid lobes.

Most of follicles however appeared partially or fully empty due to lack of colloidal materials.

Histochemical characters of follicular epithelium and the colloid were similar to that observed in principal lobe of thyroid. The parafollicular cells could not be observed in the isthmus.

TABLE – 3.

Mean ± S.E. along with C.V. % of number of follicles (per mm^2) in thyroid gland of rabbit

Structure	Animal	Mean ± S.E.	C.V. %
Follicles	Male	$187.5^a \pm 2.54$	0.043
	Female	$180.63^a \pm 6.108$	0.107

Means with same superscripts do not differ significantly.

TABLE – 4.

Showing certain histochemical properties in the thyroid gland of rabbit.

Structures	PAS with and without saliva digestion		Colloidal iron	Oil red 'O' stain	Sudan black 'B' stain	Silver method	Gomori's calcium cobalt method	Feulgen reaction
	Glycoprotein	Glycogen	Acid mucopolysaccharides	Neutral fat	Lipids	Ascorbic acid	Alkaline phosphatase	DNA (in nucleus)
Capsule & Stroma	–	–	–	–	–	–	–	+ to + +
Endothelium of blood vessels	–	–	–	–	–	–	+	+ to + +
Follicular epithelium	–to+	–	–	–	–	–	–	+ +
Follicular colloid	+ + +	–	–	–	–	–	–	–
Parafollicular cells.	–	–	–	–	–	–	–	N.R.

– = Negative + = weak ++ = Moderate +++ = Intense reaction N.R.= Not recorded

SUMMARY AND CONCLUSION

5. SUMMARY AND CONCLUSION

Histological and certain histochemical studies were made on adrenal and thyroid glands of six adult male and six adult female rabbits.

5.A. Adrenal gland :

The adrenal gland presented a central medulla and peripheral cortex. The gland was covered by thin connective tissue capsule.

5.A.a. Capsule and Stroma :

The capsule of adrenal gland was predominantly formed by collagen fibers with scantly distribution of reticular fibers. The elastic fibers were absent. Seldom few smooth muscle cells were observed in the capsule. The connective tissue strands from inner margin of the capsule descended into the gland constitute stromal network. These stromal fibers usually terminated and condensed deeply near corticomedullary junction. Rarely these fibers descended in the medulla surrounding the cortical cell clusters appearing as islands within medullary zone. The stromal framework in the adrenal medulla was made up of collagen fibers in association with fibroblasts. The average thickness of capsule in male rabbit measured 17.3 ± 0.121 μm while in female it measured 16.9 ± 0.098 μm. The difference was statistically significant. Histochemically, the adrenal capsule and the stromal fibers showed negative reaction for glycogen, neutral mucopolysaccharides, acid mucopolysaccharides, lipids, ascorbic acid and alkaline phosphatase. The blood vessels distributed in the capsule and stroma occasionaly showed mild reaction for alkaline phosphatase on endothelial margin.

5.A.b. Adrenal Cortex :

The adrenal cortex of rabbit revealed two definite zones namely zona glomerulosa and zona fasciculata – reticularis from outside in. The zona

intermedia was lacking. The zona glomerulosa was composed of zona glomerulosa cells which were arranged in spherules or hemispherules at the sub capsular part of the cortex. Zona fasciculata-reticularis was made up of zona fasciculata cells and zona reticularis cells. These two cellular zones did not reveal distinct line of demarcation. Therefore the combined zone had been termed as zona fasciculata – reticularis.

The thickness of adrenal cortex in male rabbit (1221.16 ± 1.96μm) was significantly higher than in female rabbit (1177.28 ± 5.107μm).

5.A.b.a. Zona glomerulosa :

The average thickness of zona glomerulosa measured 107.2 ± 0.12 μm in male and 99.6 ± 0.88 μm in female rabbit. The difference was significant at 5% level. The zona glomerulosa cells were pyramidal or low columnar in shape having round or oval nucleus. The cytoplasm was eosinophilic and vacuolated. A prominent nucleolus was usually found in the nucleus paracentrally. These cells were negative for glycogen, glycoprotein, neutral mucopolysaccharides and alkaline phosphatase. The cells were mild to moderately reactive for lipids and ascorbic acid. The nuclei were moderately positive for DNA.

5.A.b.b-c. Zona fasciculata – reticularis :

The average thickness of this combined zone was 1096.66 ± 1.99 μm in male and 1060.78 ± 4.879 μm in female rabbit. The difference between these two sexes was significant at 5% level.

5.A.b.b-c.(i) Zona fasciculata cells :

These cells were polyhedral or oval in shape. The cytoplasm was faintly acidophilic and granular showing few vacuoles. The vesicular nucleus was spherical. The binucleated cells were not found. Zona fasciculata cells were arranged in radial column or cord separated by sinusoids. Histochemically these cells were negative for PAS, glycogen, acid

mucopolysaccharides and alkaline phosphatase. The cells were moderate to intensely reactive for oil red 'O' and moderately reactive for Sudan black B. The reaction for ascorbic acid varied from mild to moderate degree. Nuclei were mildly reactive for DNA.

5.A.b.b-c.(ii) Zona reticularis Cells :

These cells were comparatively smaller than zona fasciculata cells and were arranged in irregularly anastomosing cell cords at the deepest part of the adrenal cortex. These cells invaded the medulla obliquely or in curved manner to appear as cortical cell island in that area. The zona reticularis cells appeared oval or polyhedral in outline having acidophilic cytoplasm. The nucleus was more basophilic having oval or round outline. Histochemically the cells were negative for glycogen, glycoprotein, acid mucopolysaccharides and alkaline phosphatase. The cytoplasm was mild to moderately positive for lipids and mildly reactive for ascorbic acid. The nuclei were mildly Feulgen reactive.

5.A.c. Adrenal medulla :

The adrenal medullary cells were oval or columnar in shape. The cytoplasm appeared coarsly granular. The large vesicular nucleus appeared oval or spherical in outline. Usually prominent nucleolus was present in the nucleus. The medullary cells arranged in cell cords or cell cluster in the form of small follicles and were separated from each other by sinusoidal network. With special staining method viz. Giemsa stain and Wood's Eosin - Aniline Blue stain only epinephrine containing cells were observed in the medulla apart from a few cortical cell island. Histochemically the medullary cells were negative for PAS positive substances, acid mucopolysccharides, lipids,

ascorbic acid and alkaline phosphatase. Nucleus was mild to moderately reactive for DNA.

5.B. Thyroid gland :

The thyroid gland of rabbit was comprised of two thyroid lobes and a long isthmus duely covered by capsule.

5.B.a. Capsule and Stroma :

The thyroid gland of rabbit was covered by capsule made up of irregular connective tissue. It predominated with the distribution of collagen fibers with occasional presence of reticular fibers. The stroma of the thyroid gland of rabbit was formed by loose connective tissue dividing each lobes into various lobules like structures. The perifollicular capillary network was prominent. Histochemically the capsule and stroma were negative for PAS reaction, acid mucopolysccharides, lipids, ascorbic acid and alkaline phosphatase. The nuclei of connective tissue cells were however reactive for DNA. Mild positivity for alkaline phosphatase was recorded at the luminal margin of blood vessels.

5.B.b. Thyroid follicles :

The thyroid follicles were small spherical to large oval in outline. In case of male the follicular population was recorded as 180.5 ± 2.45 per mm^2 area whereas in female it remained 180.63 ± 6.108 per mm^2 area. Statistically the difference was non-significant.

5.B.b.a. Follicular epithelium :

The thyroid follicles were lined with simple cuboidal epithelium in most of the cases. The extremely larger follicle however showed simple squamous epithelial lining. The cuboidal epithelial cells showed clear cell boundries with terminal bars. The cytoplasm was finely granular and

acidophilic. The nucleus was oval or round and was normally placed parabasally. The cells of the simple squamous epithelium however contained hyperchromatic flattened nucleus. The height of the epithelium in male rabbit varied between 8.9 μm to 14.28 μm with an averaged 10.44 ± 1.99 μm. In female the epithelial height ranged from 5.69 μm to 13.45 μm with an average height 9.85 ± 0.24 μm. Histochemically intracellular PAS positive granules could not be recorded in the cells of simple squamous epithelium. The cuboidal follicular cells however showed mild reaction for PAS occasionally at their supra nuclear cytoplasm. The follicular cells were negative for glycogen, acid mucopolysaccharides, lipids, ascorbic acid and alkaline phosphatase. The nuclei of the follicular cells were moderately reactive for DNA.

5.B.b.b. Follicular colloid :

Majority of follicles contained acidophilic colloidal materials. Some of the follicles appeared empty in both sexes. Occasionally desquamated cells from the follicular epithelium appeared in the colloid. The wavy outline and vacuolations in the colloid were occasionally recorded. In some of the follicles, the colloid appeared, very thin and fibrinous. Apart from acidophilic character the colloid variable shades of basophilia were also recorded. Histochemically the colloid was strongly reactive for glycoprotein and negative for glycogen, acid mucopolysaccharides, lipids, ascorbic acid and alkaline phosphatase. With special staining (DesMarias and Lattam, 1962) the colloidal materials in each animals stained orange or blue with a few follicles containing admixture of blue or orange colloidal mass. The blue colloid was suggestive for iodinated colloid, whereas orange non-iodinated

one. It appeared that iodination of the colloid usually took place in almost all the follicles simultaneously.

5.B.c. Parafollicular cells :

The parafollicular cells were usually distributed within the interfollicular cell clusters. Occasionally these cells were distributed in basal zone of follicular epithelium. These cells presented light coloured cytoplasm showing argyrophilic. The nucleus was oval or round and hyperchromatic. Histochemically the parafollicular cells were PAS negative.

5.B.d. Isthmus :

The long narrow isthmus contained quite a few number of follicles covered by loose connective tissue. The follicular outline was usually irregularly oval. Histological features of follicular epithelium were similar to those of thyroid lobe. Most of the follicles however, appeared partially or fully empty. Histochemical character of follicular epithelium and colloid resembled like those of principal lobe of the thyroid. The parafollicular cells were not found in the isthmus.

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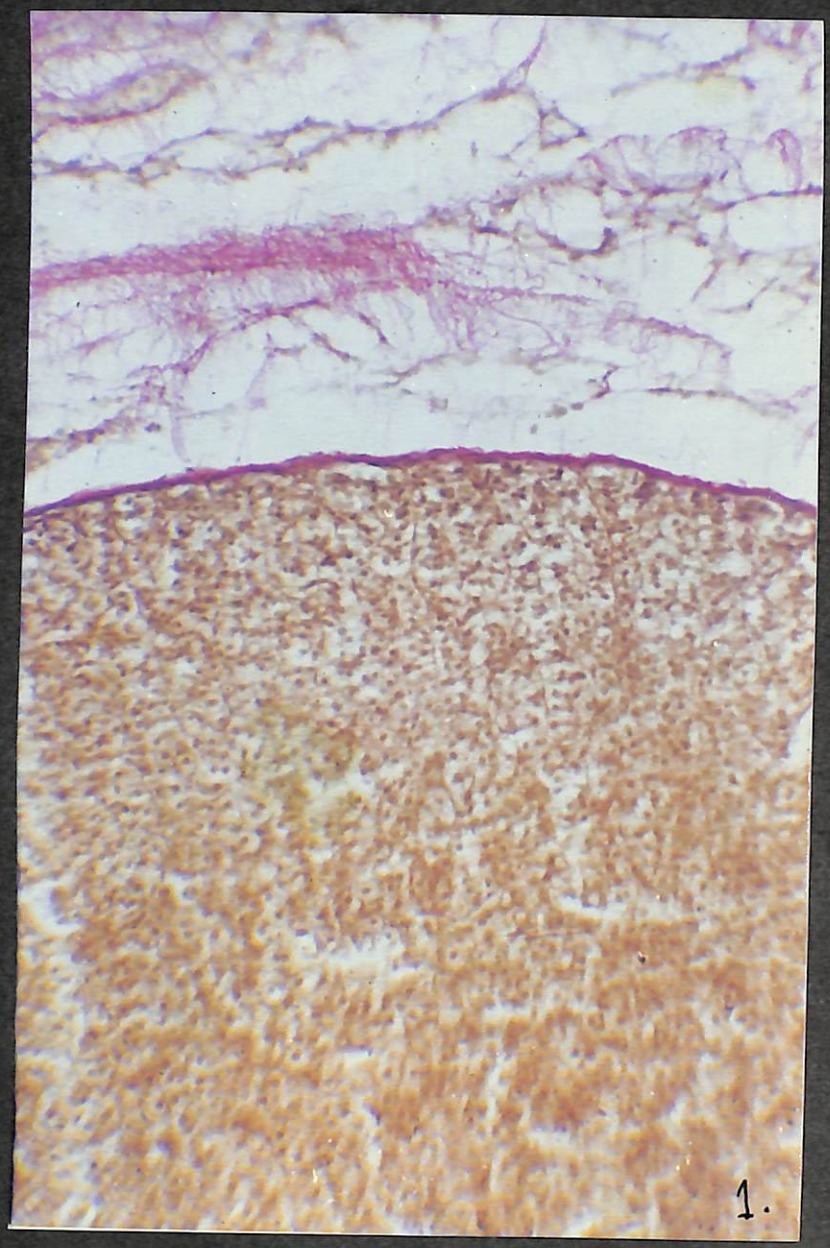
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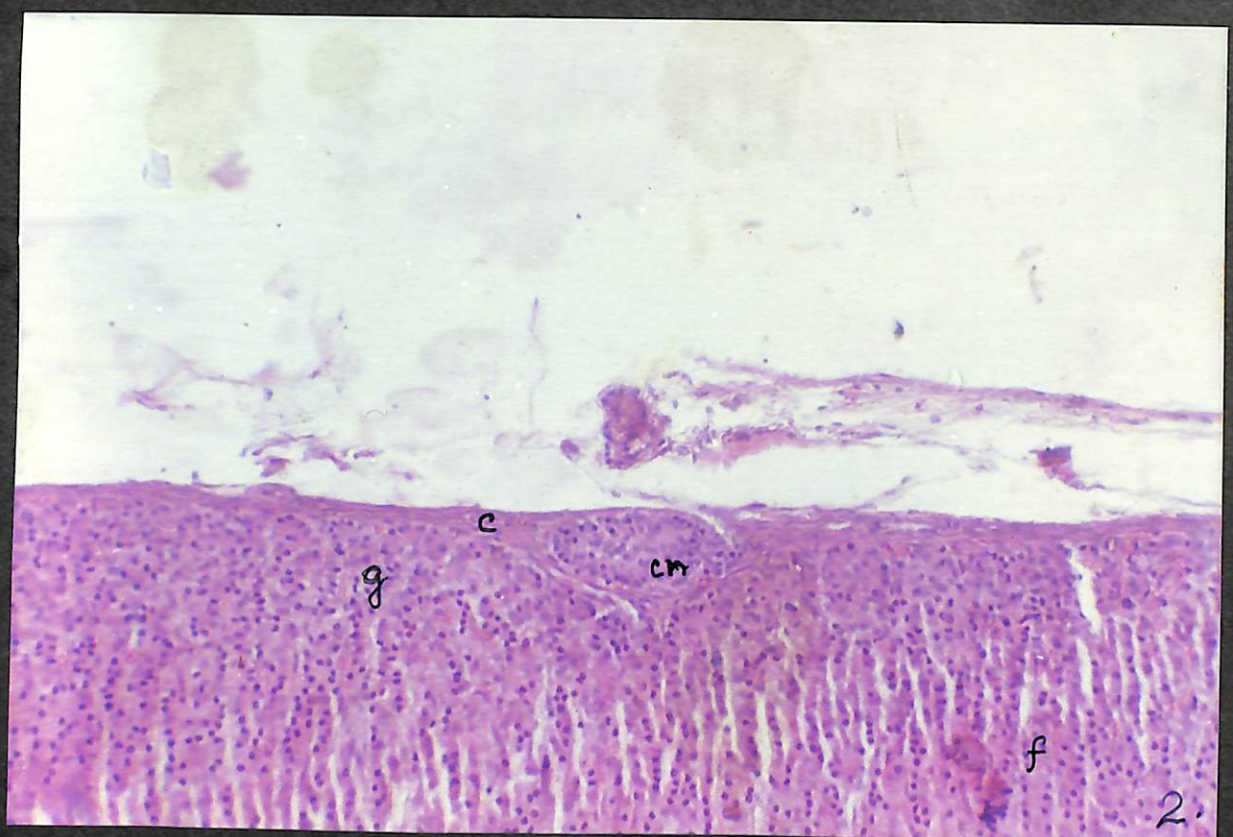
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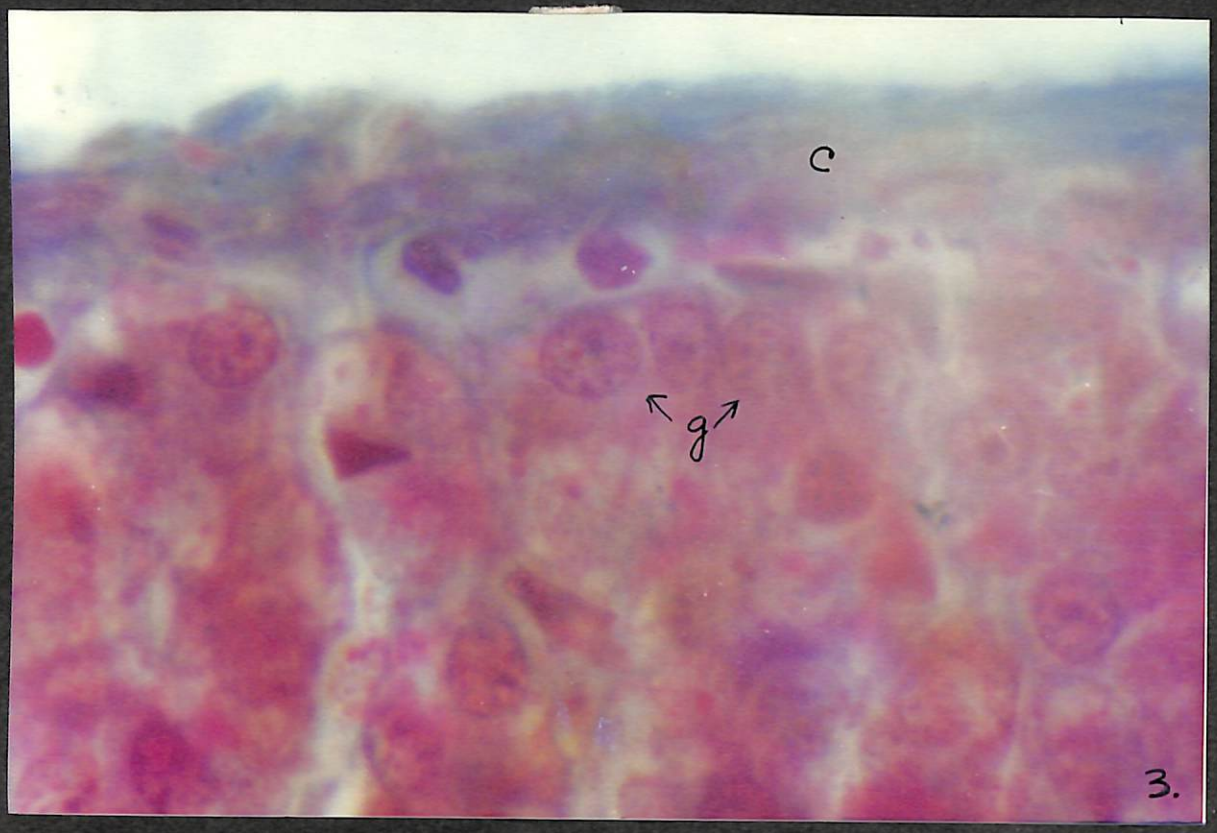

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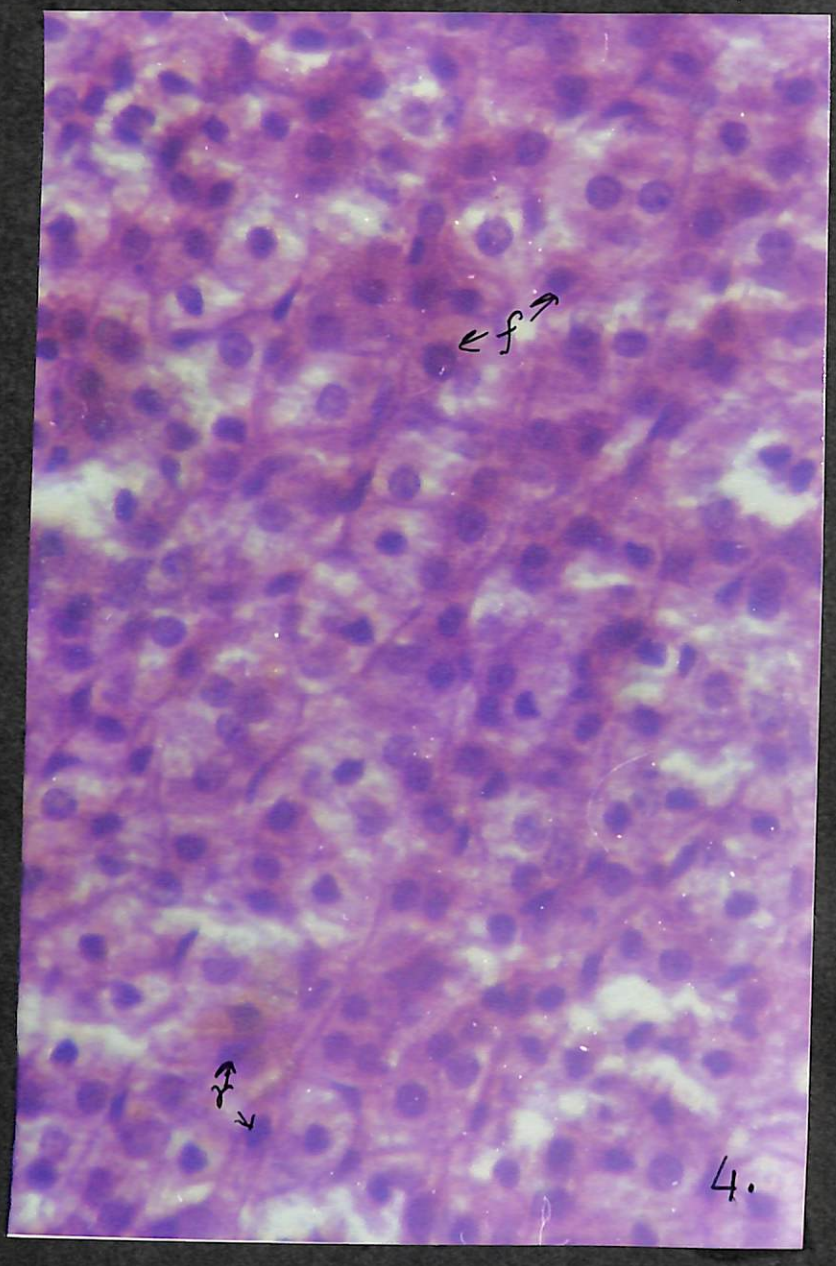

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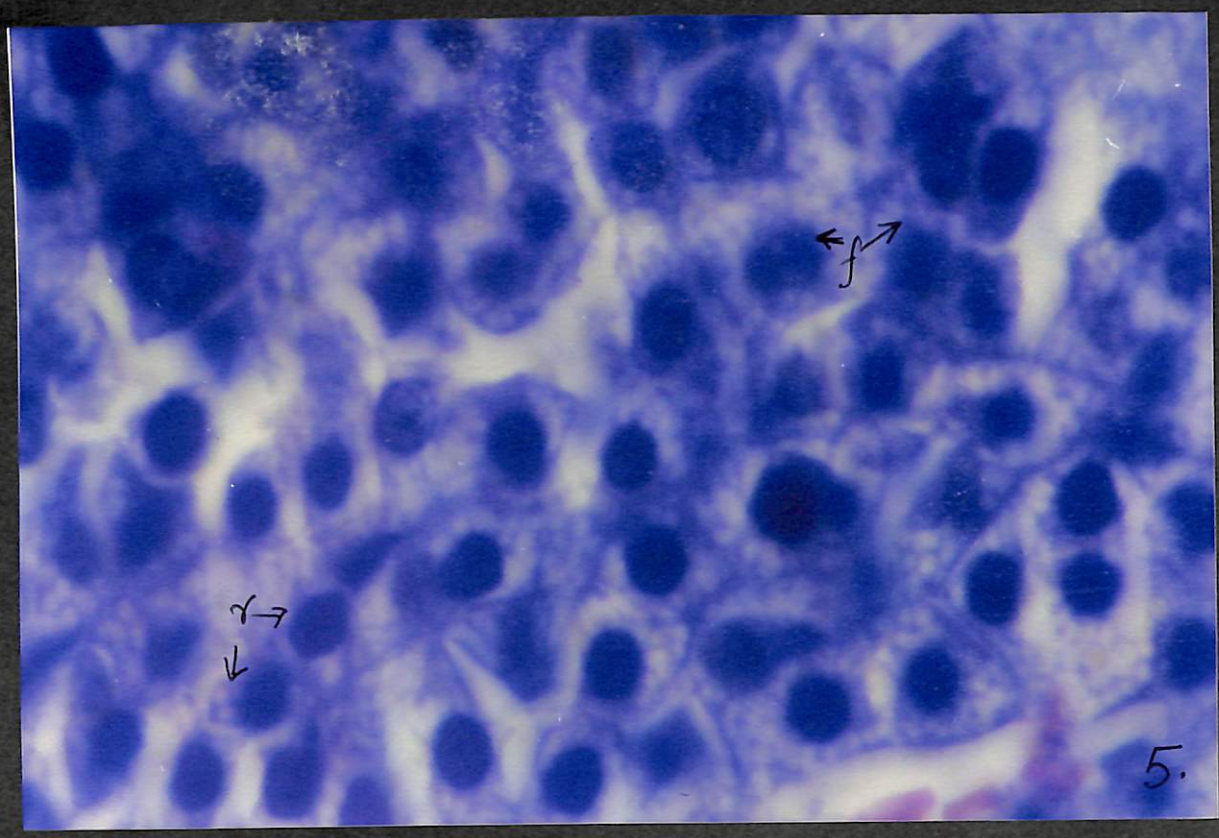
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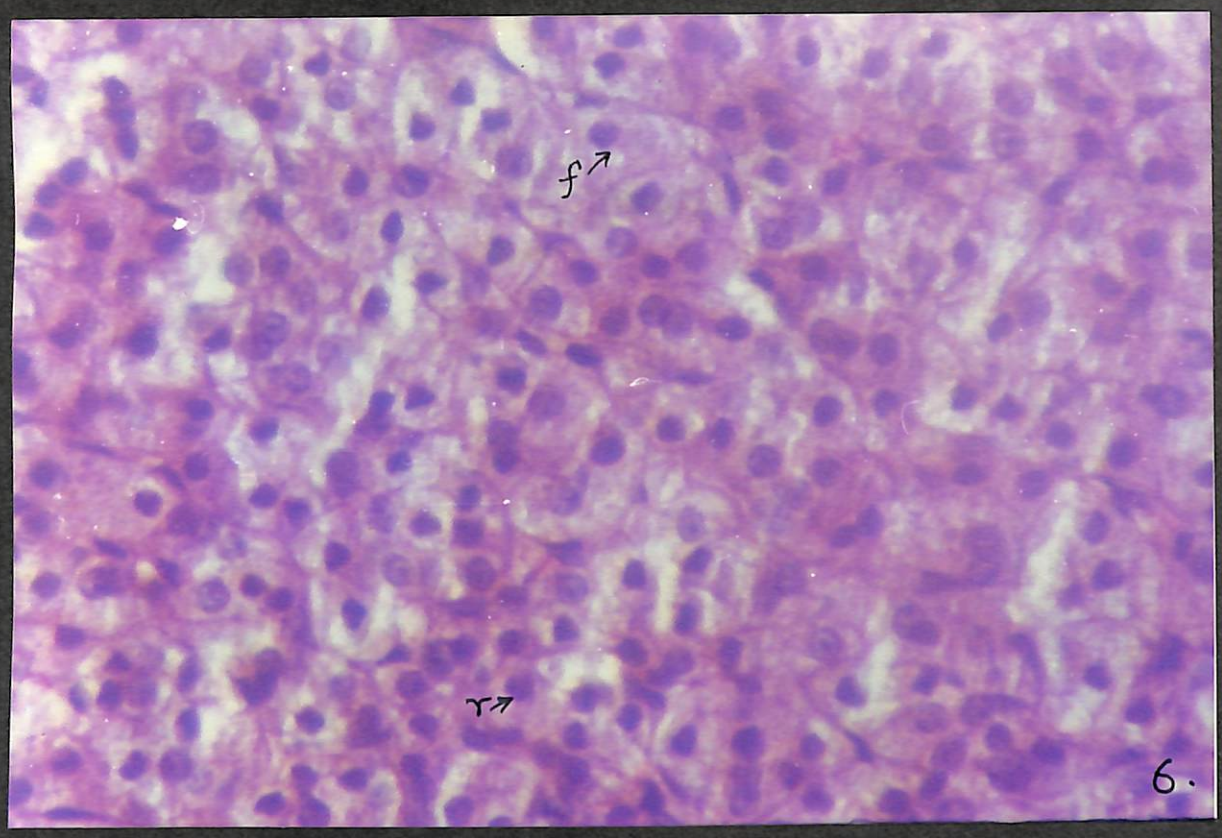
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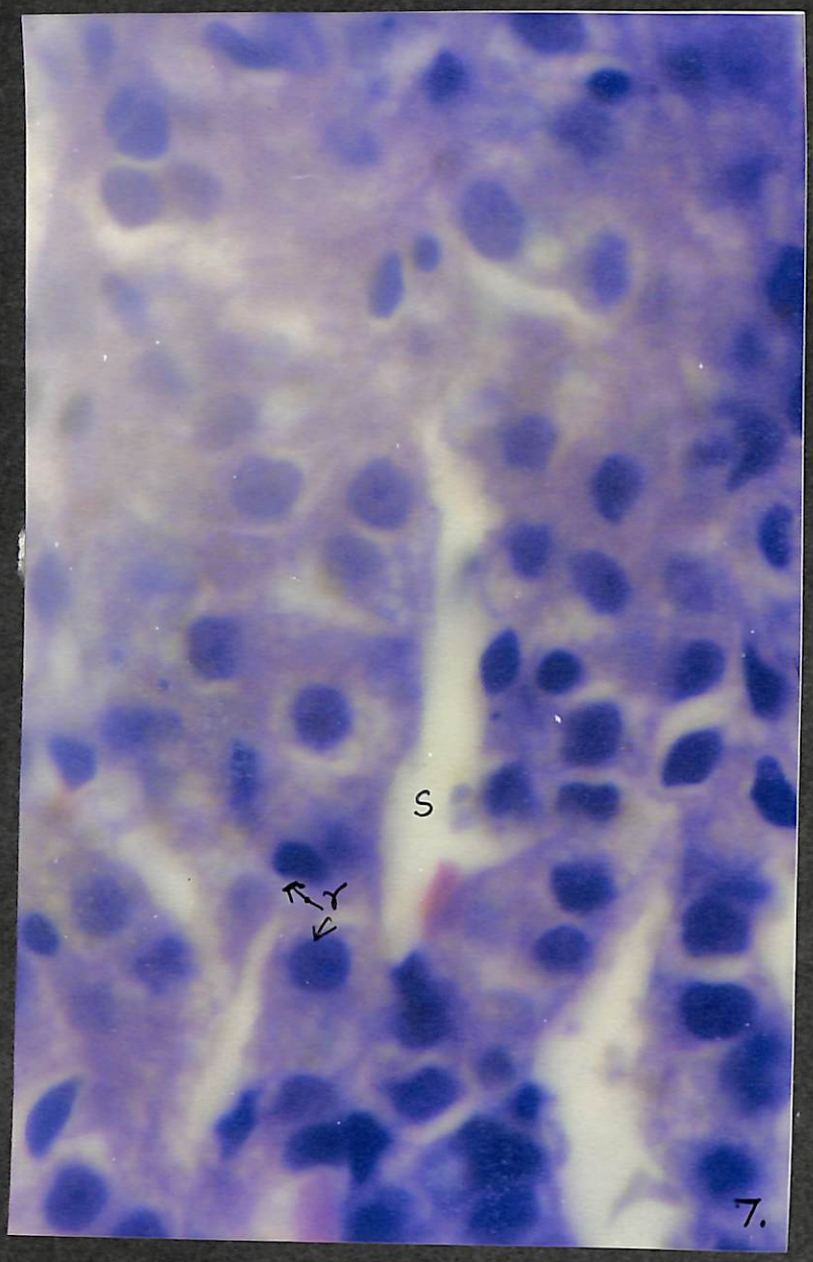
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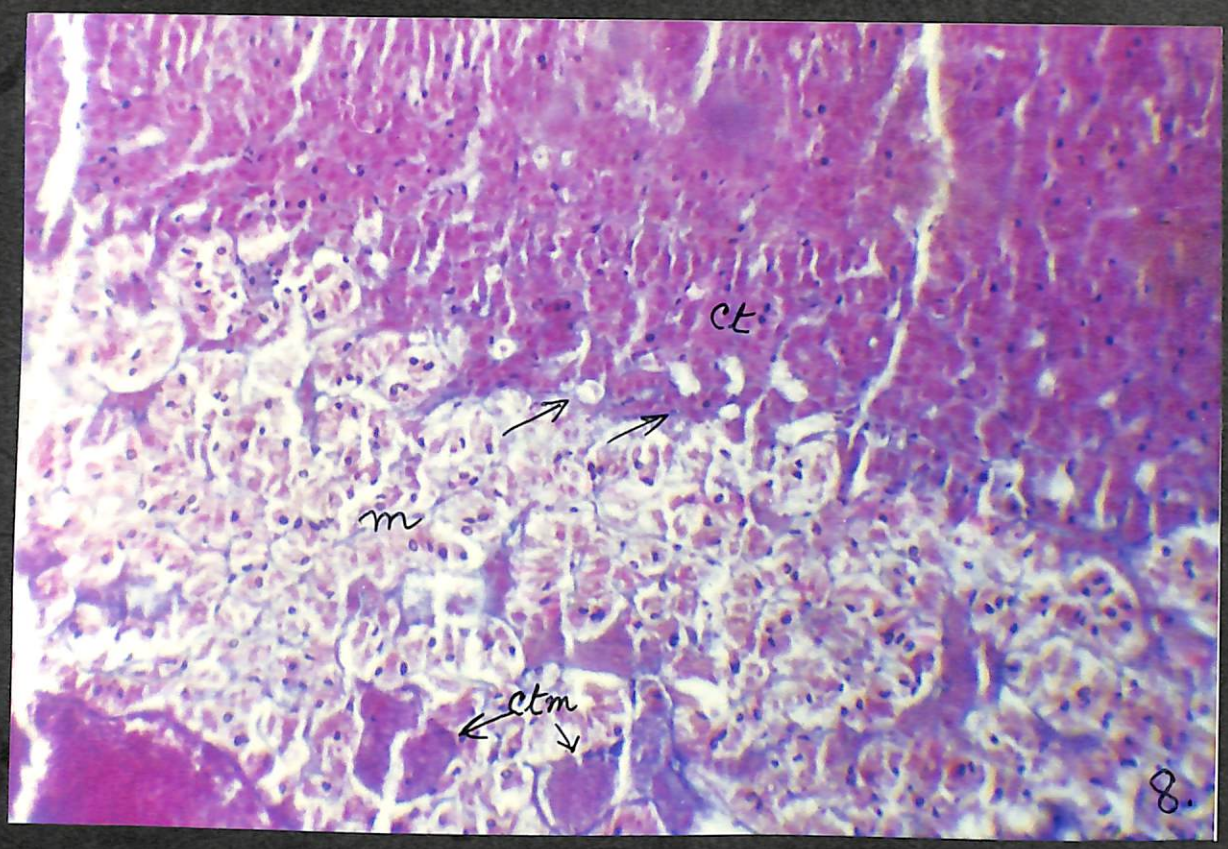
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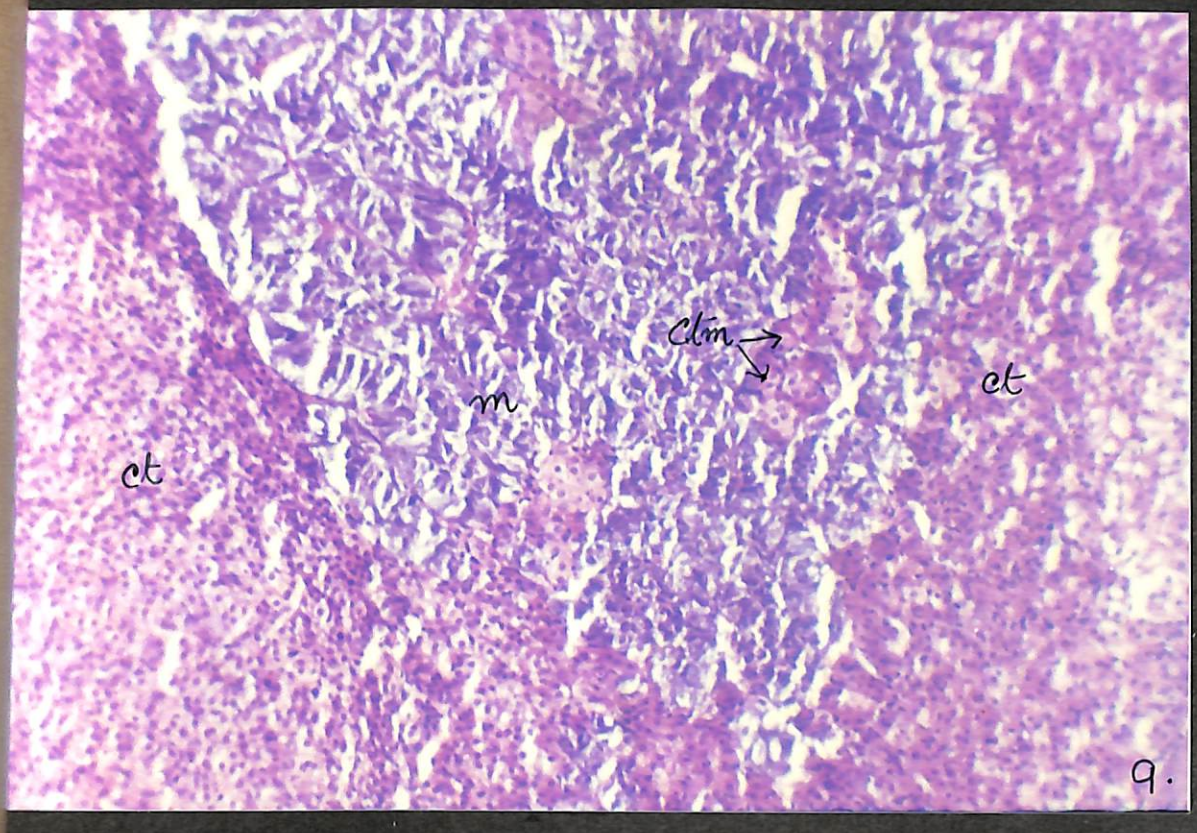

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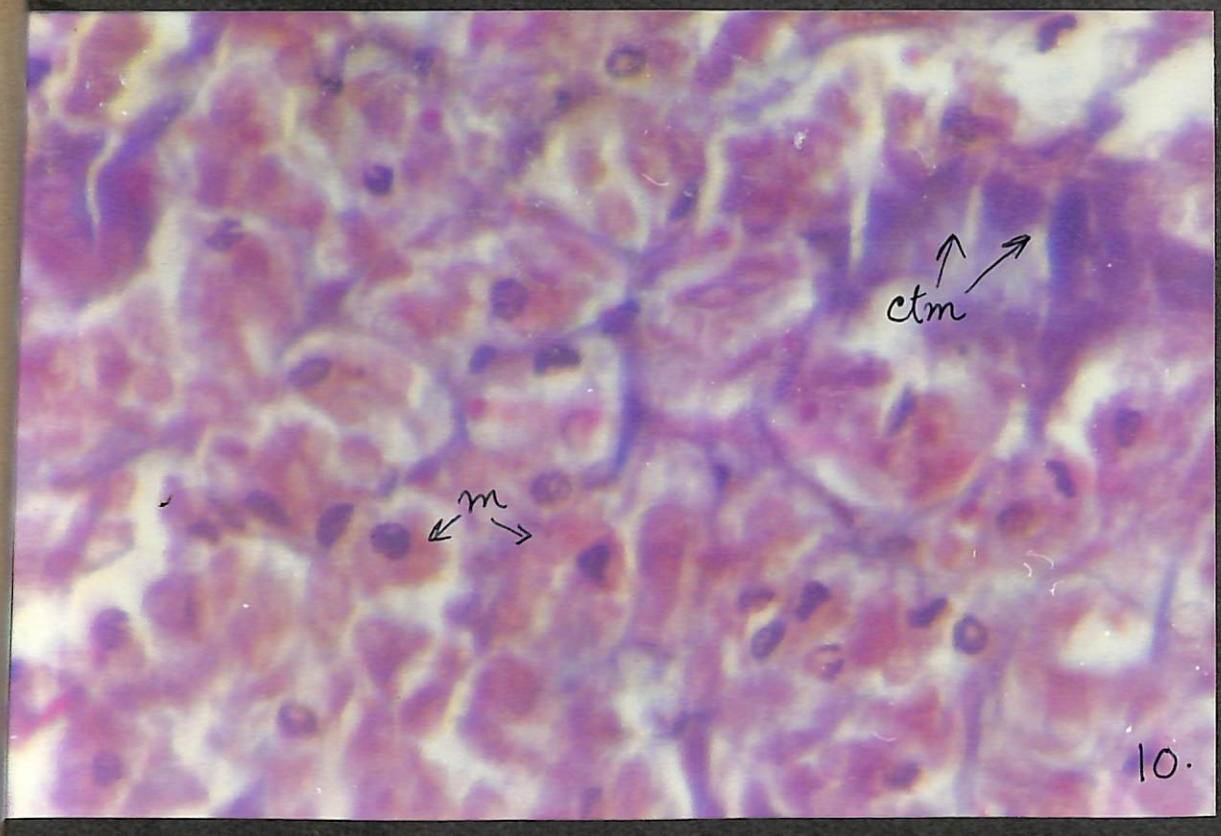

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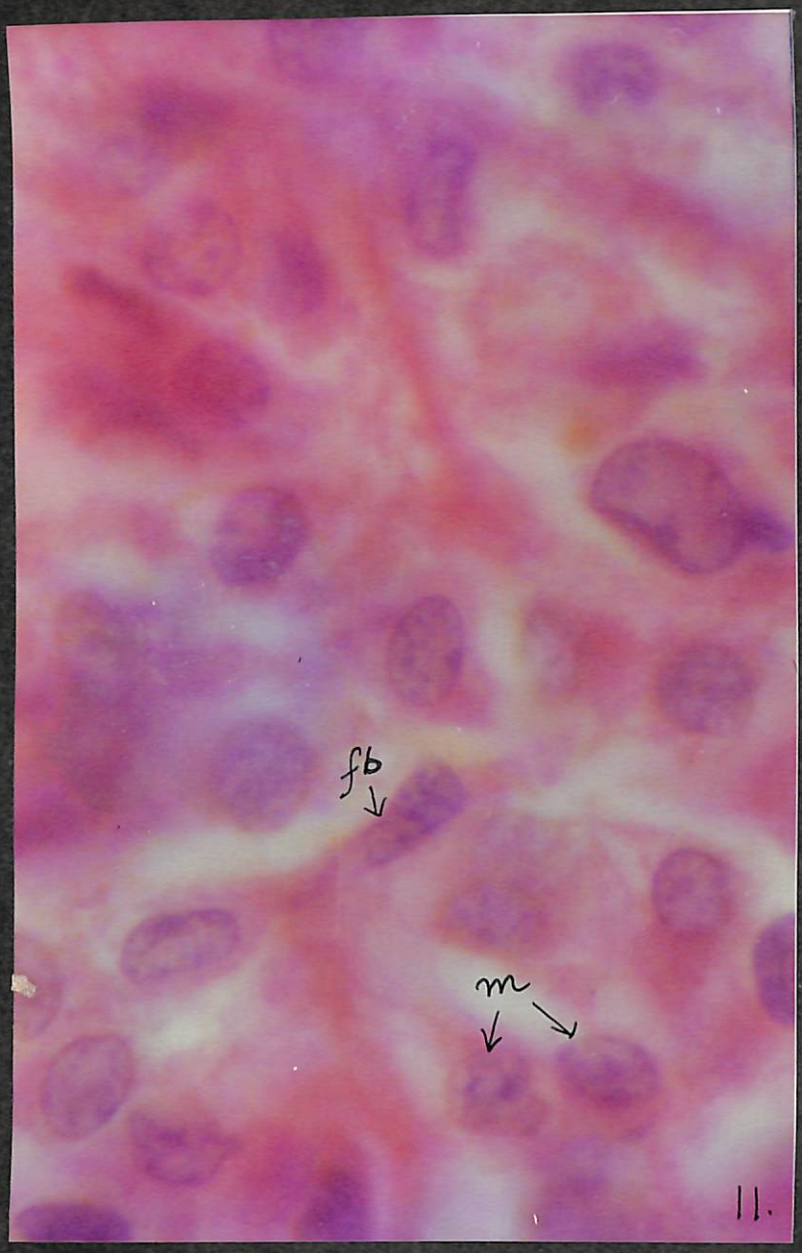

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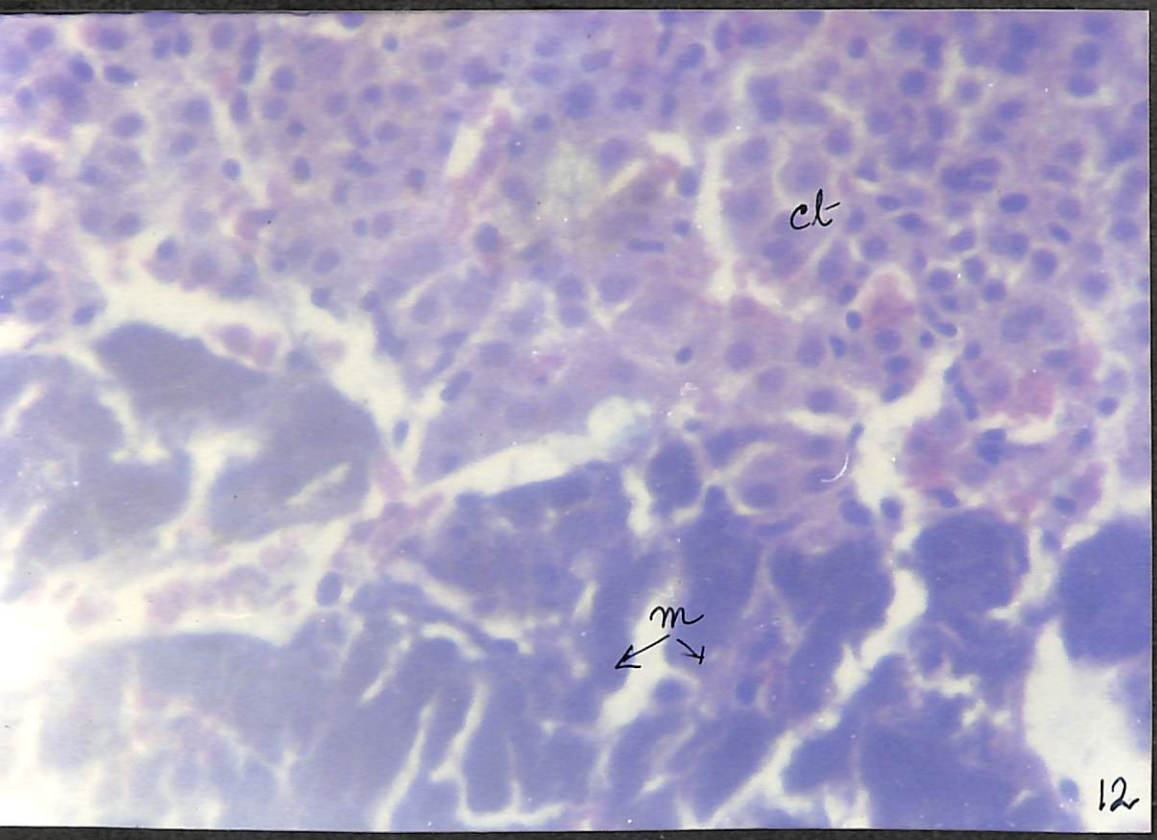

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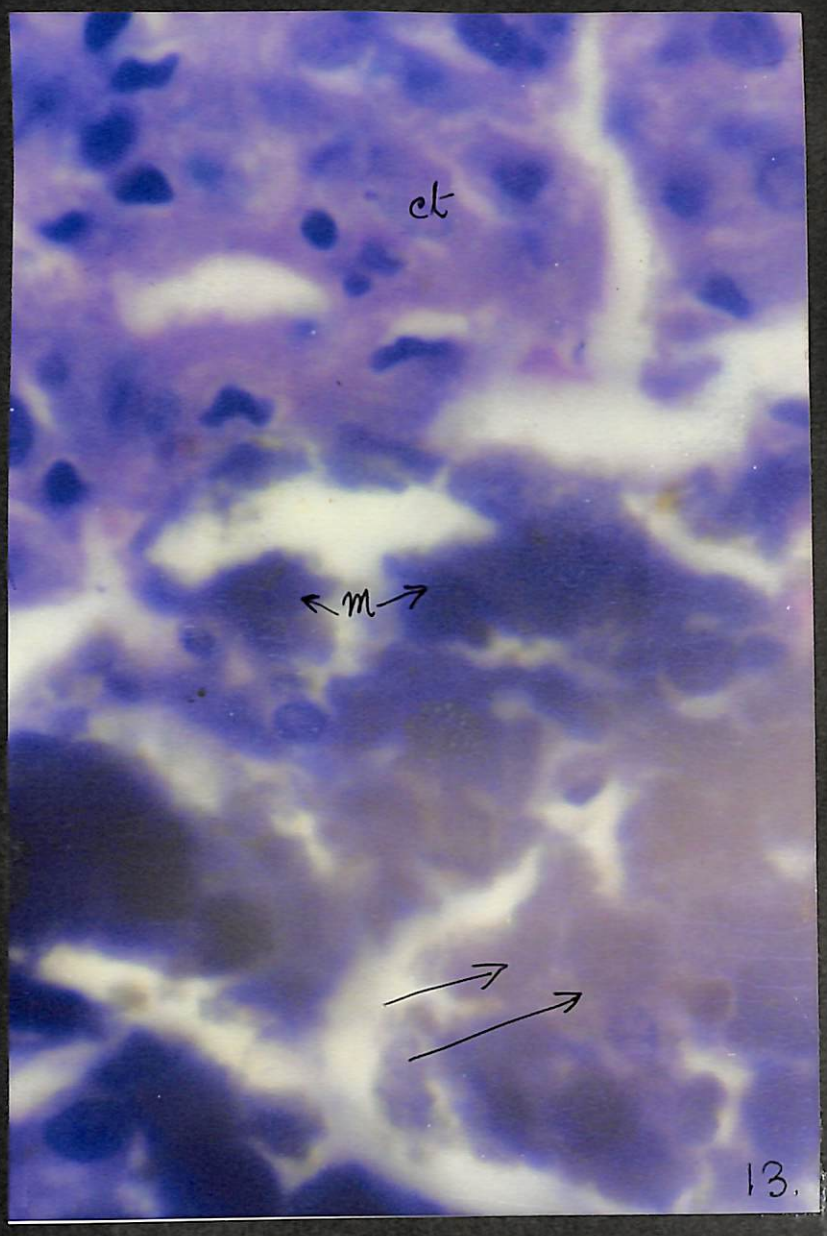

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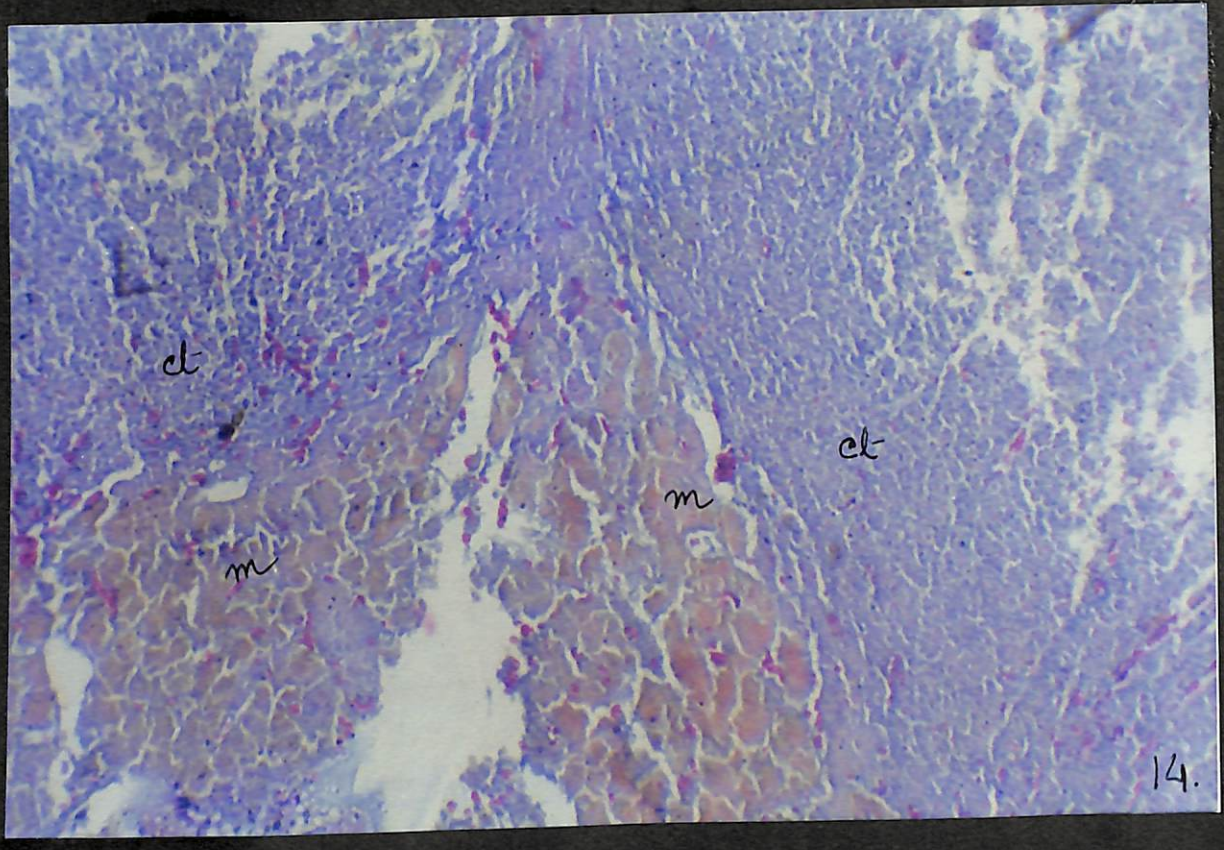

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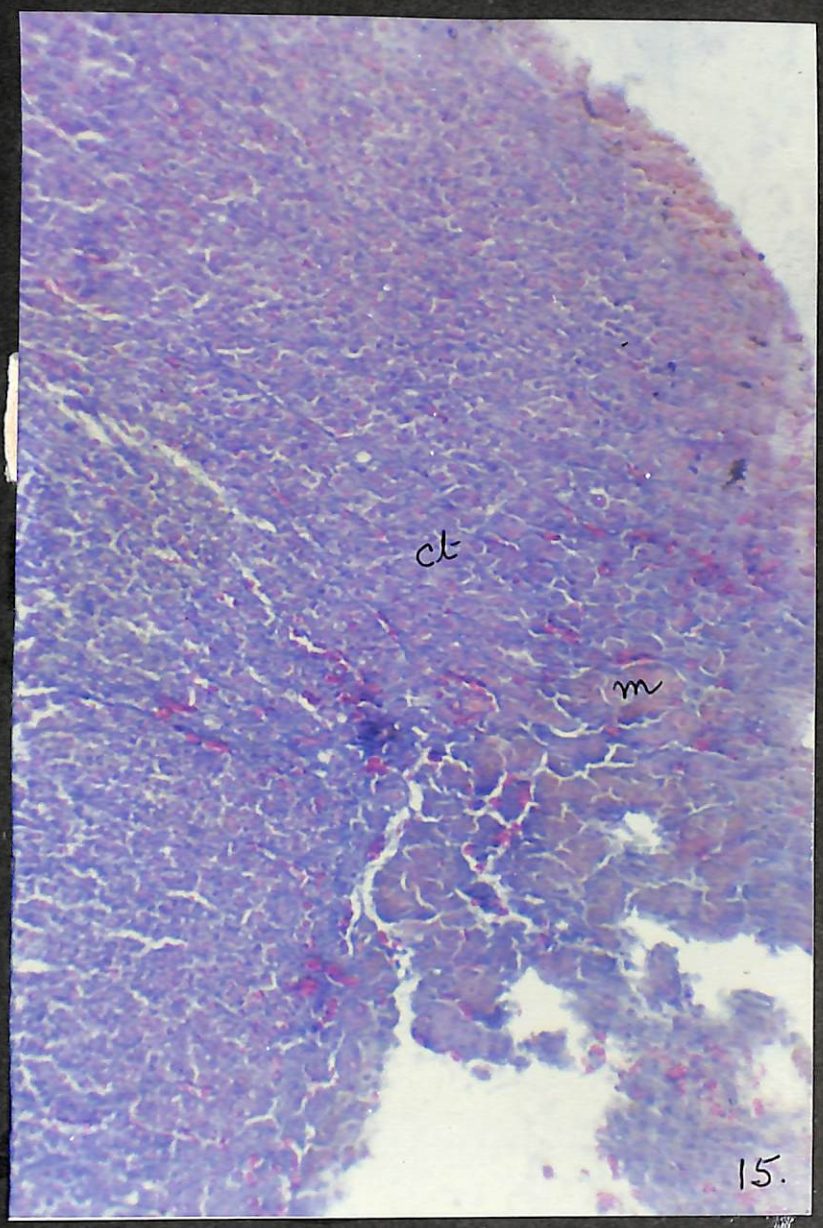

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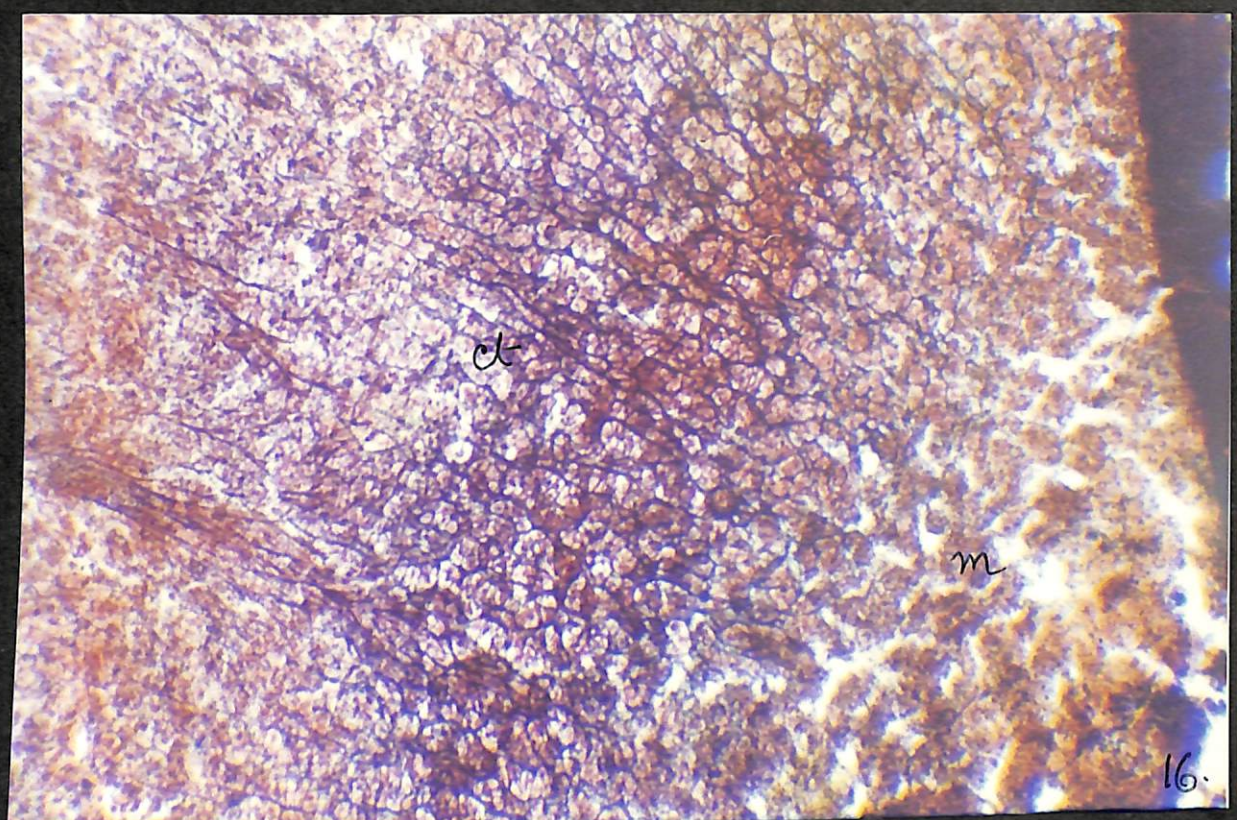

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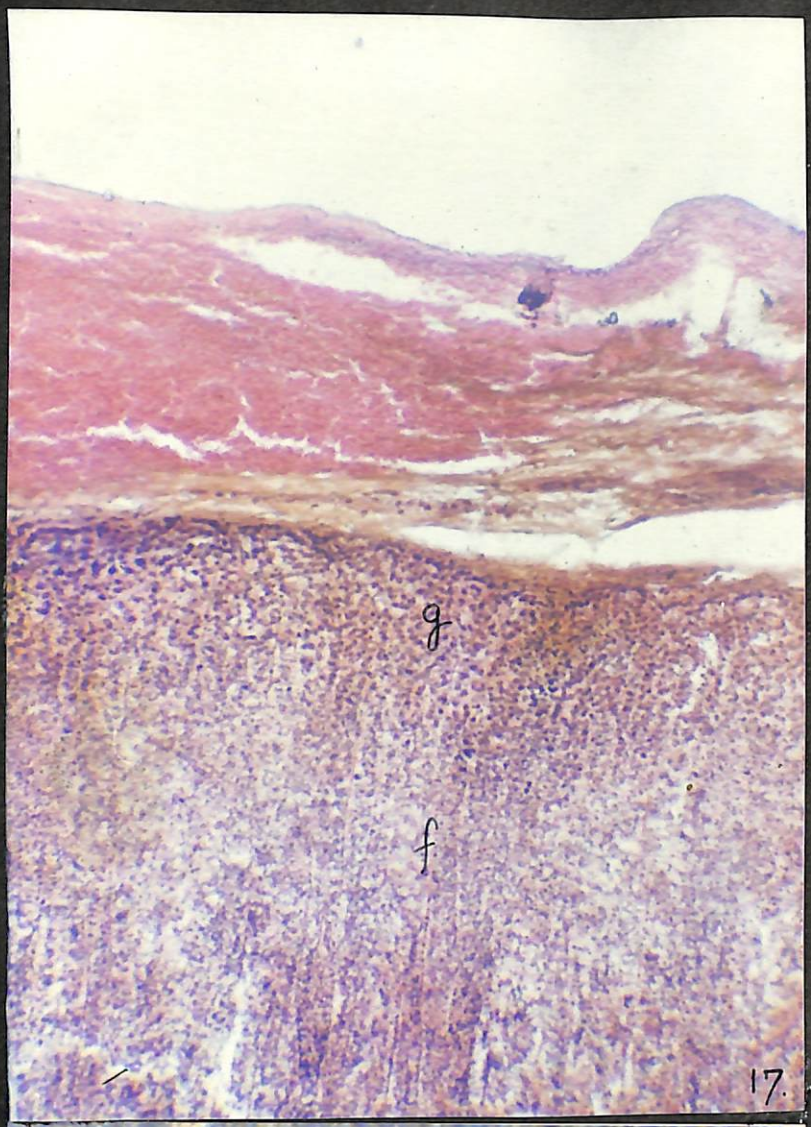

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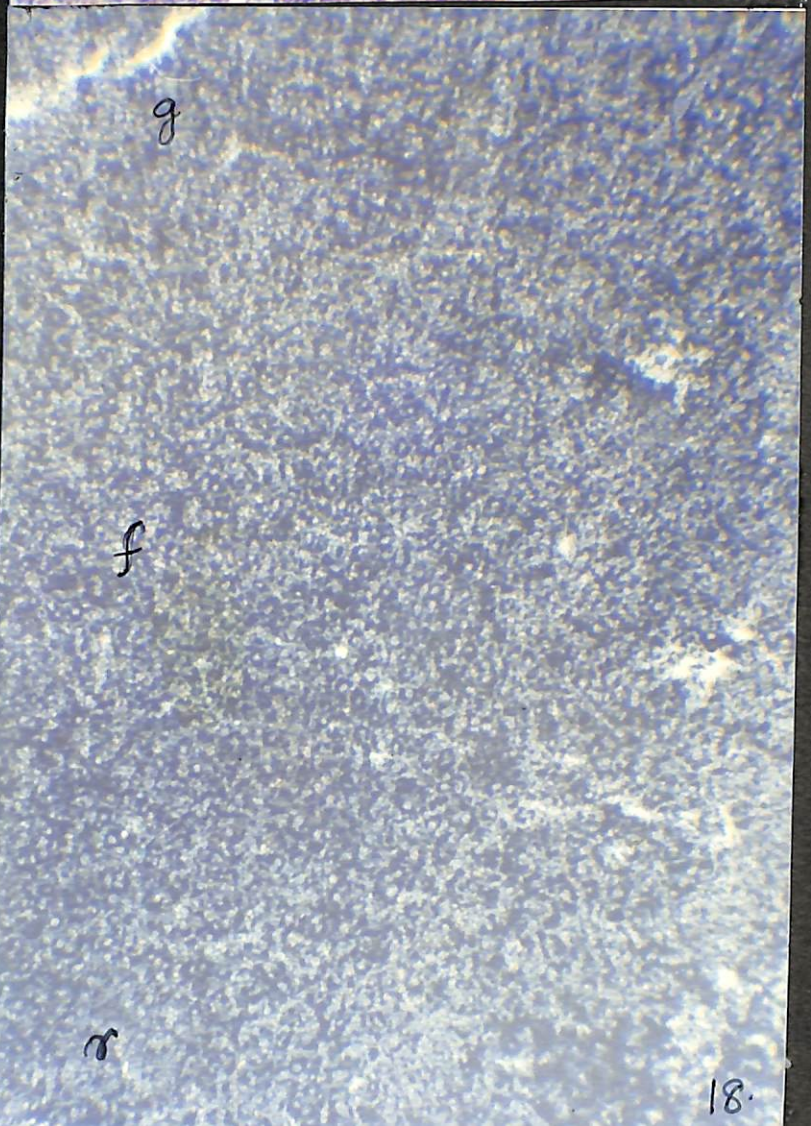

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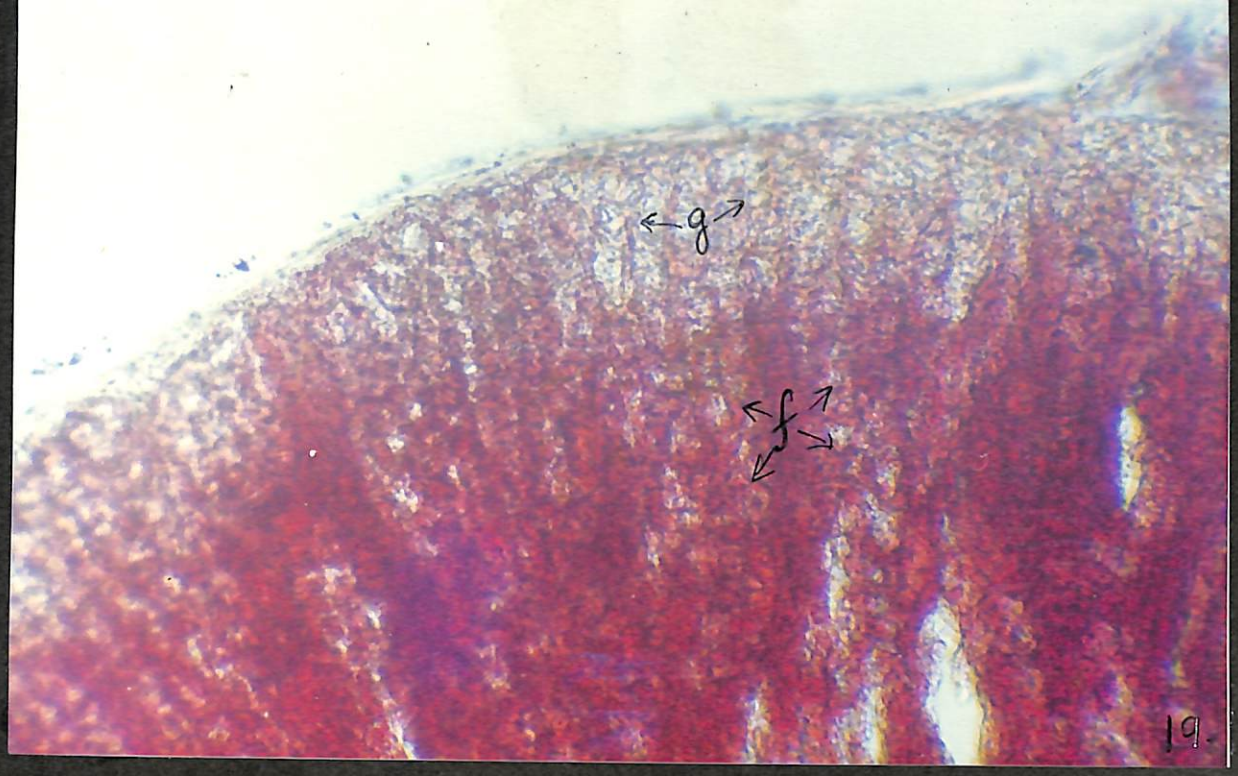

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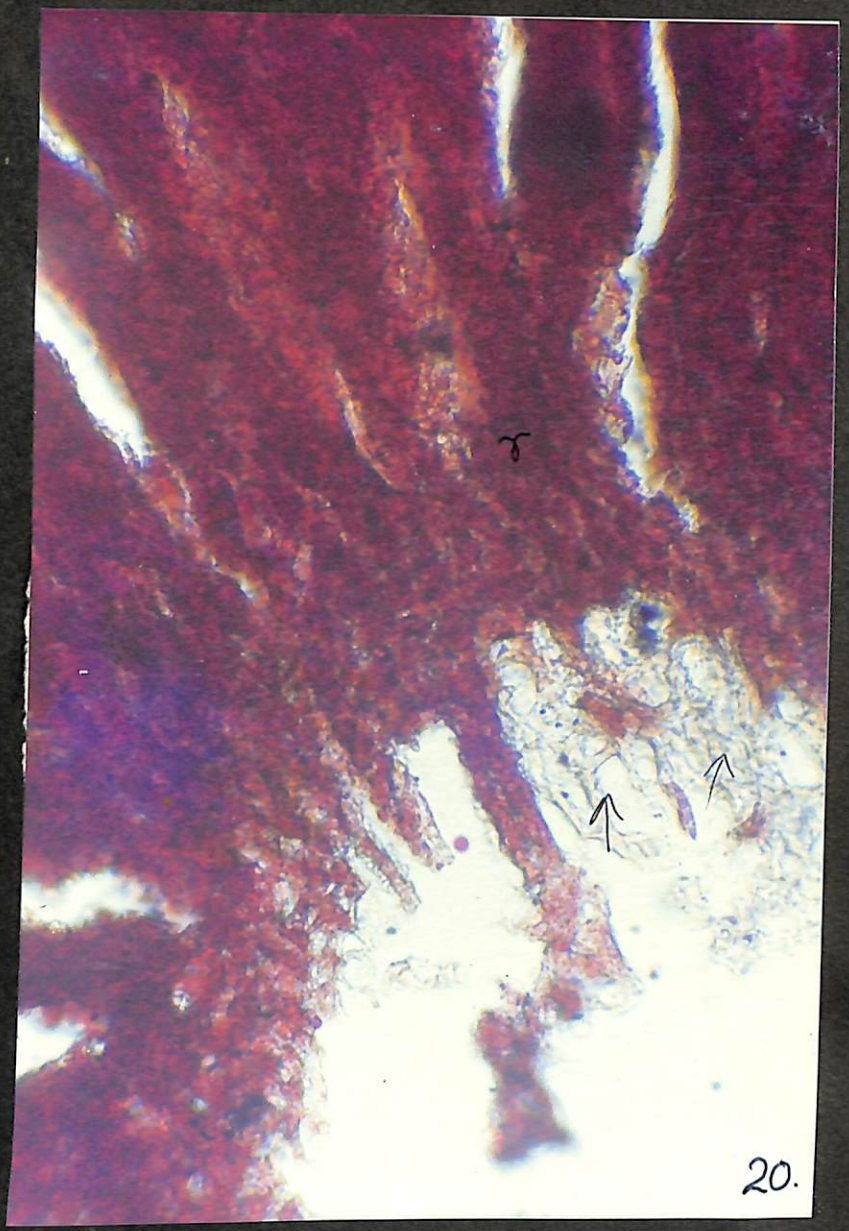

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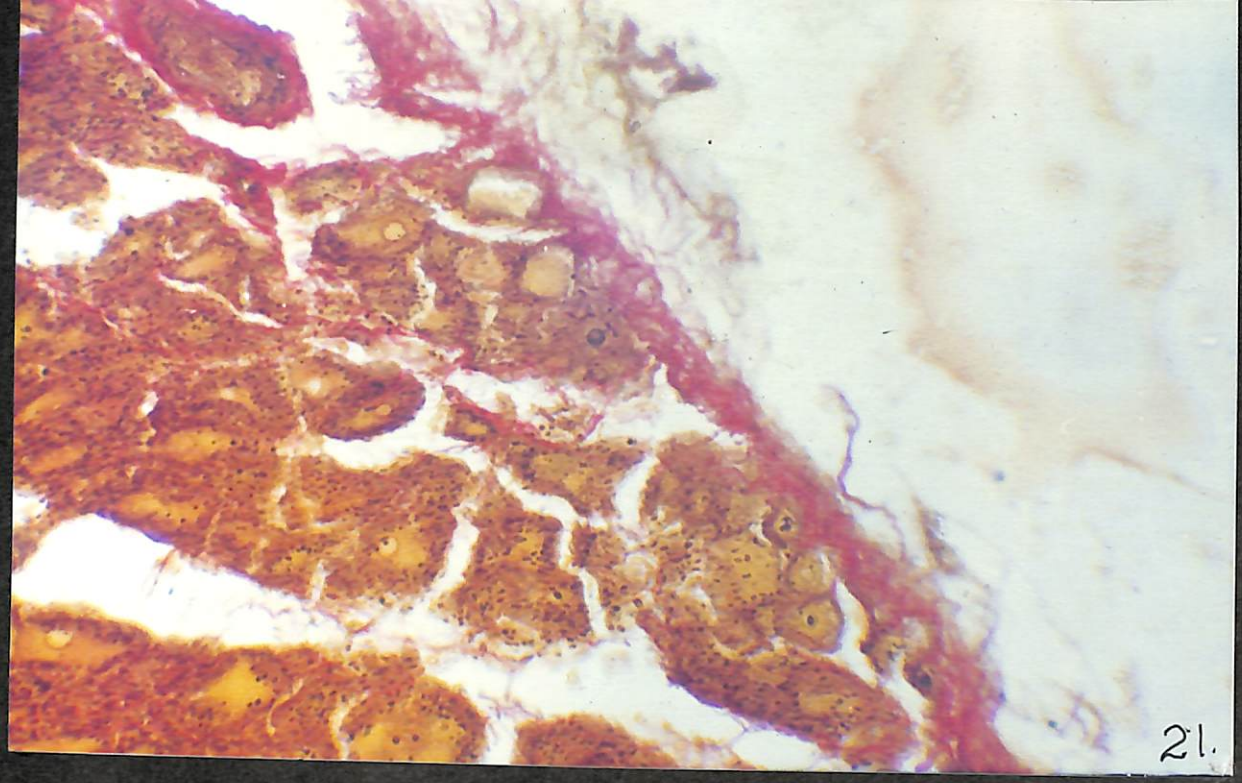

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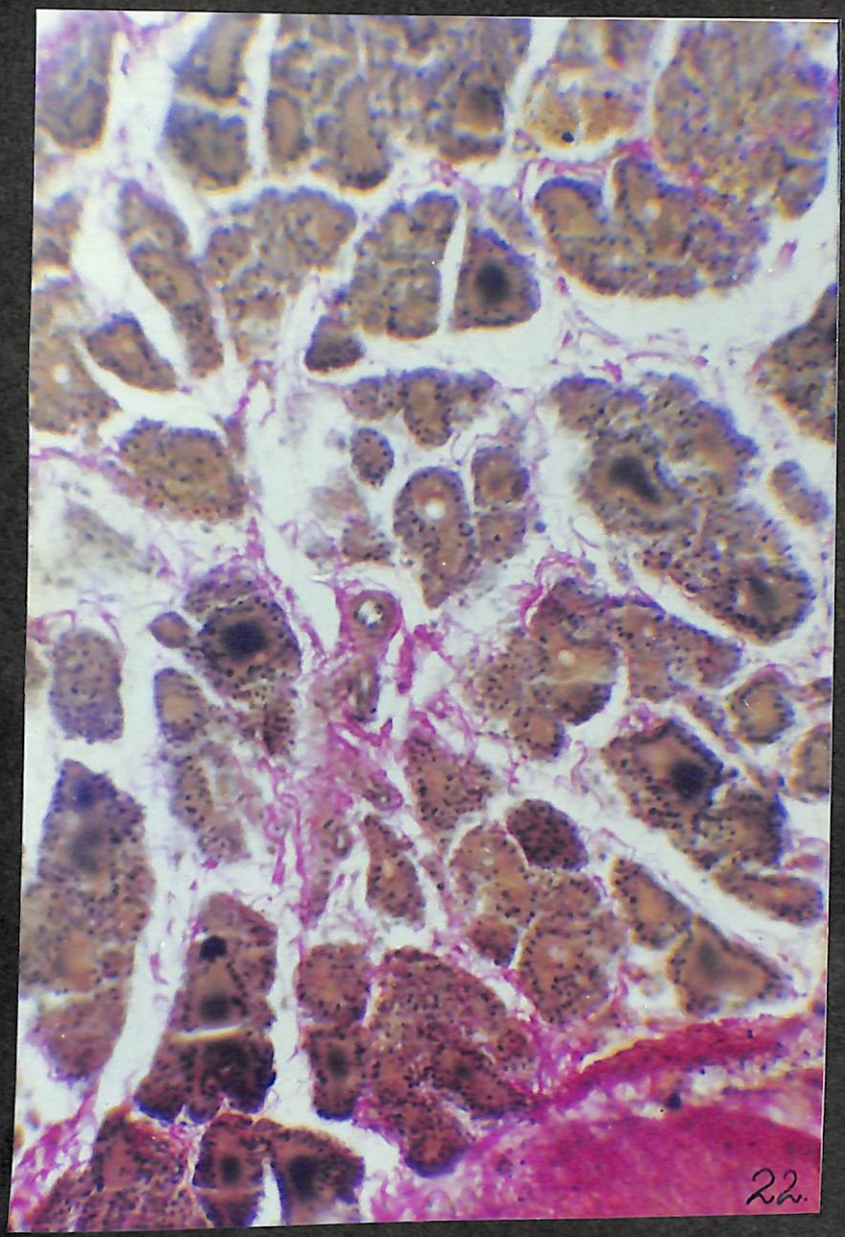

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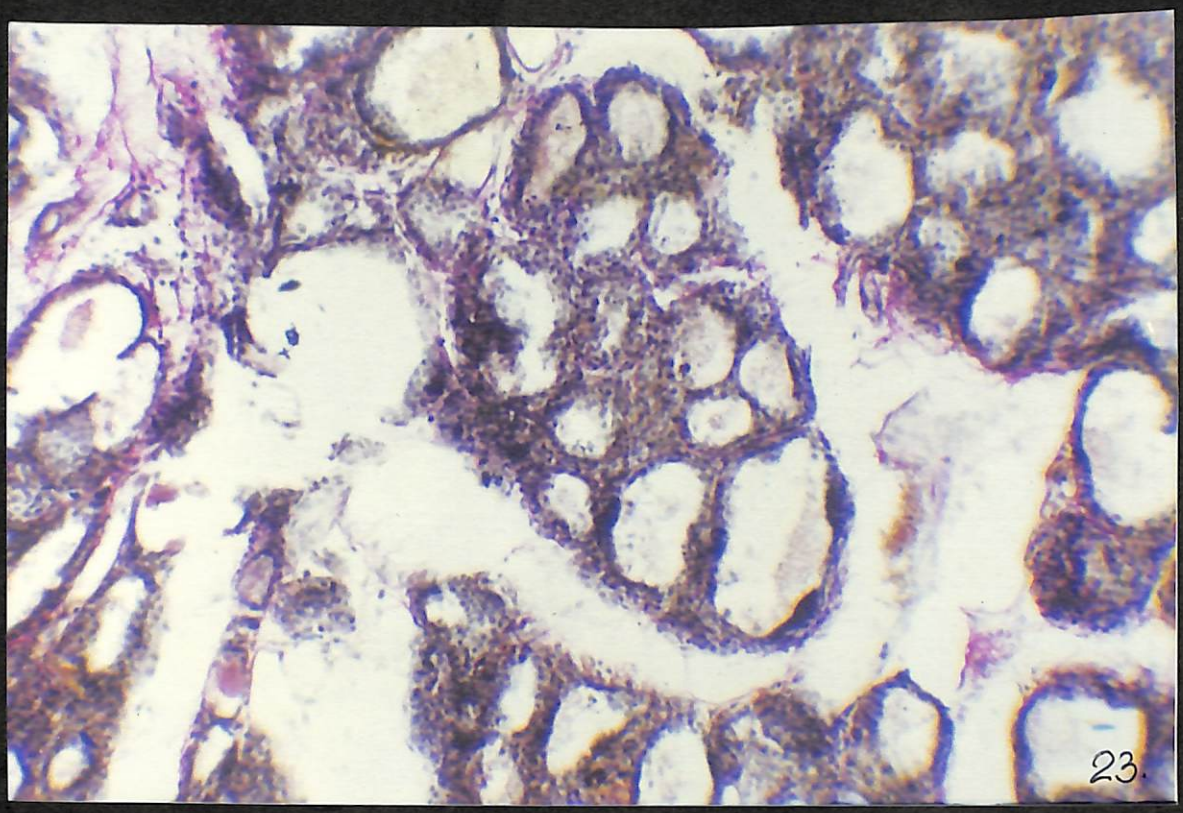
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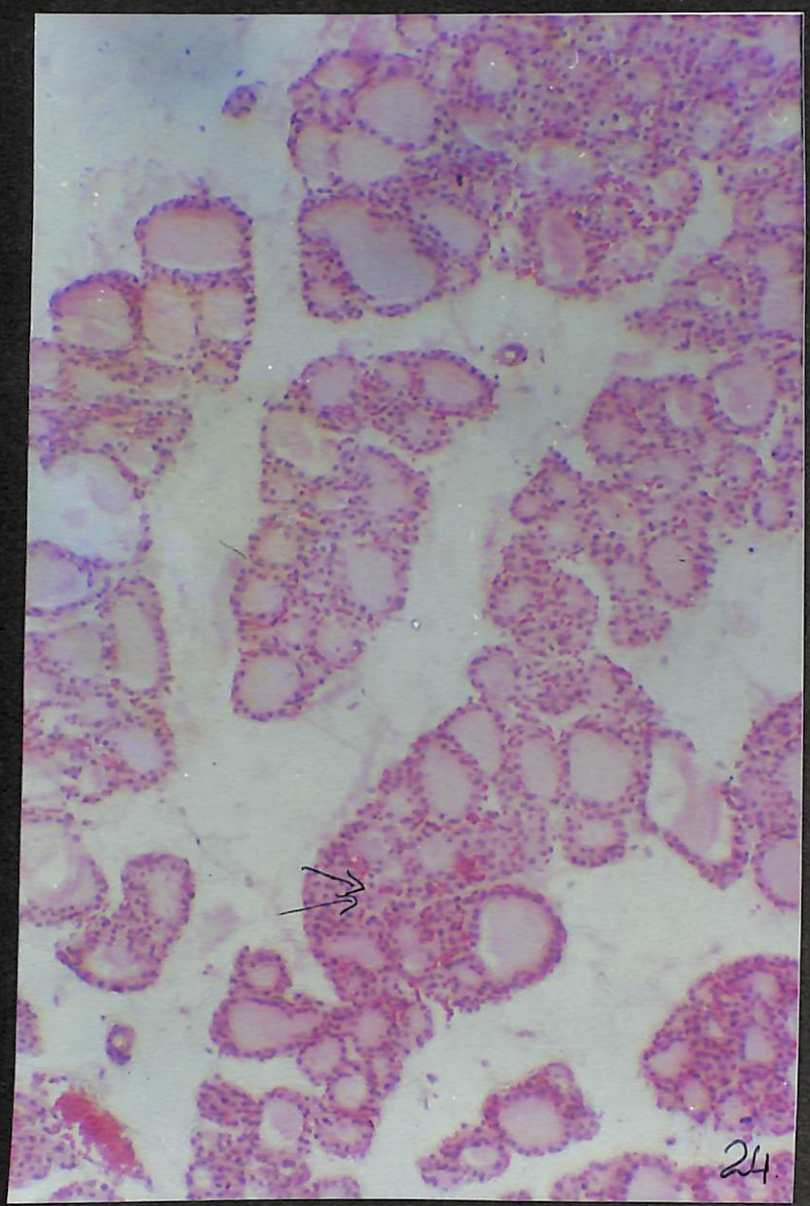
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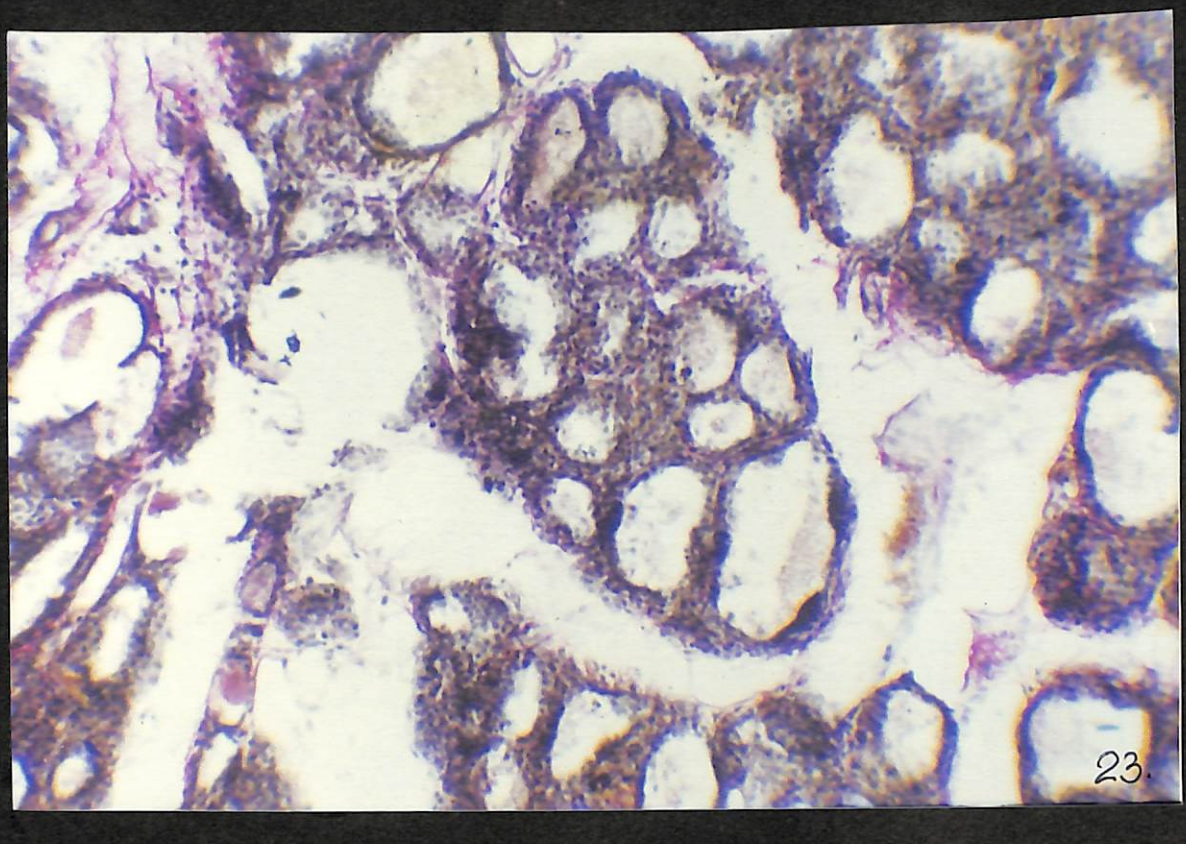
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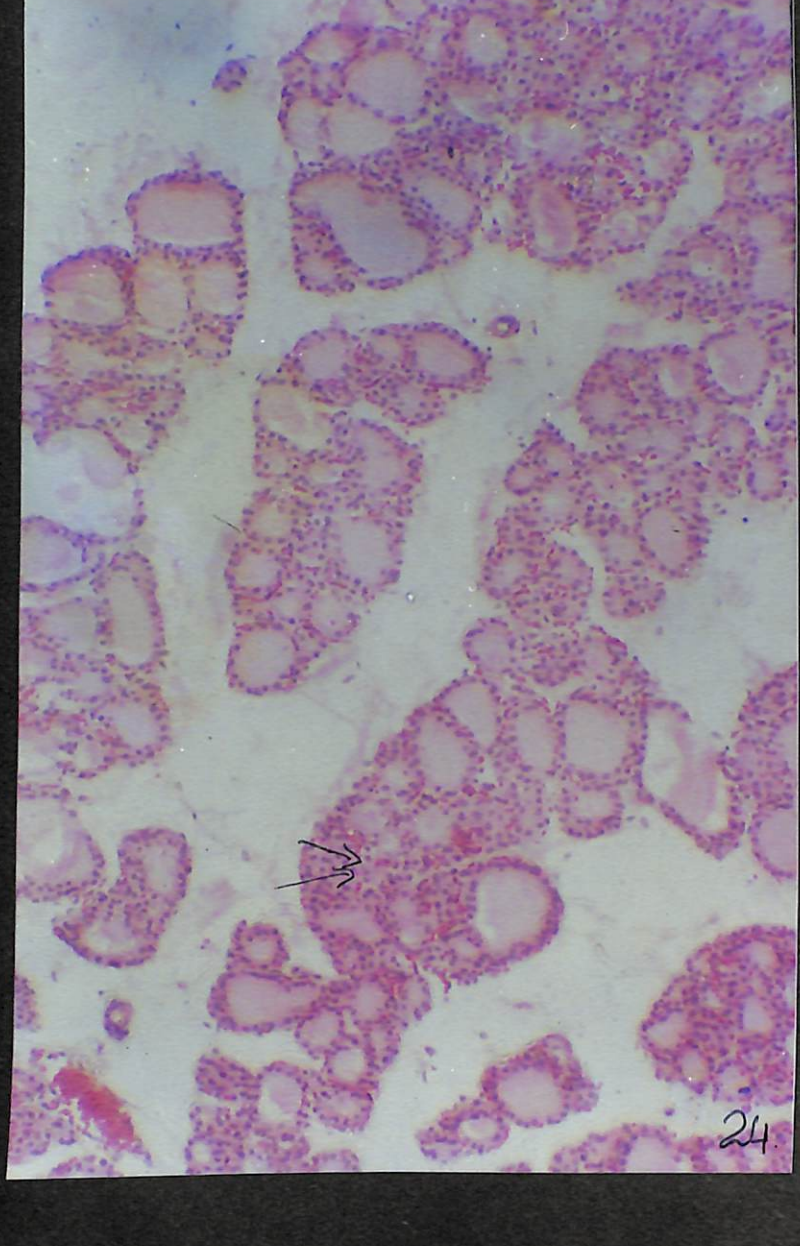
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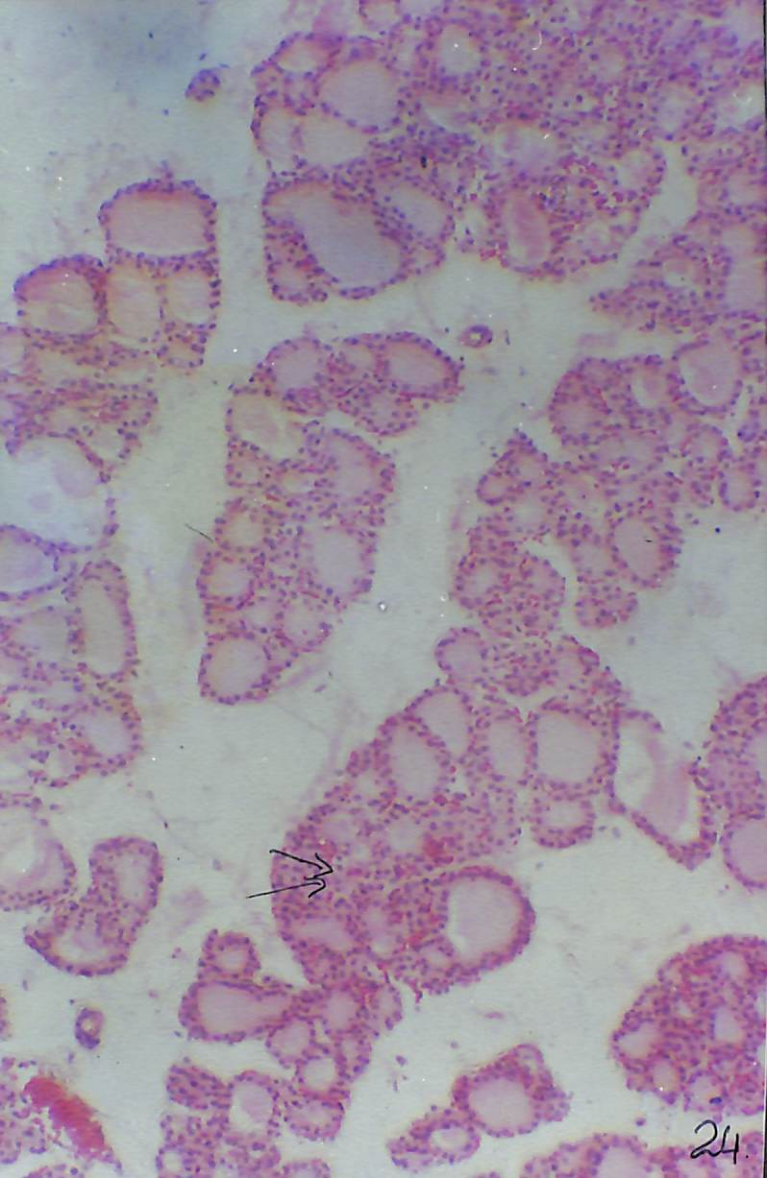

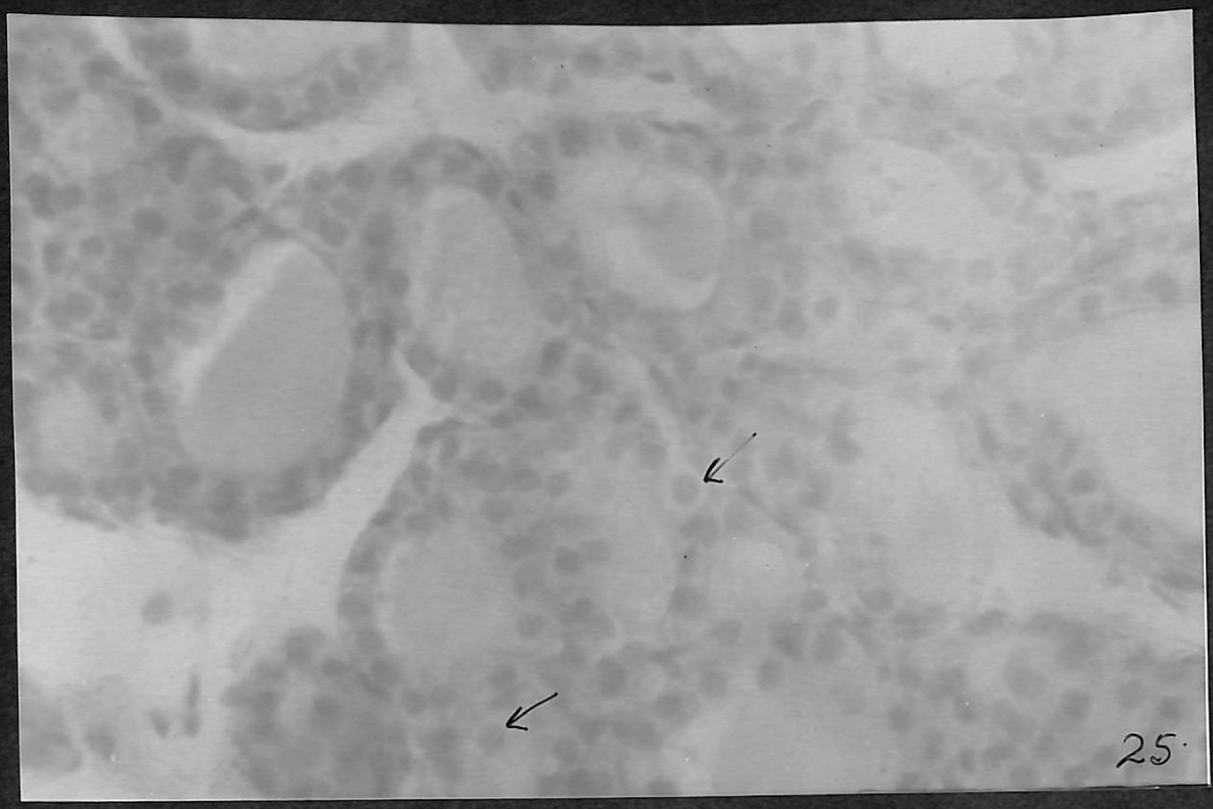

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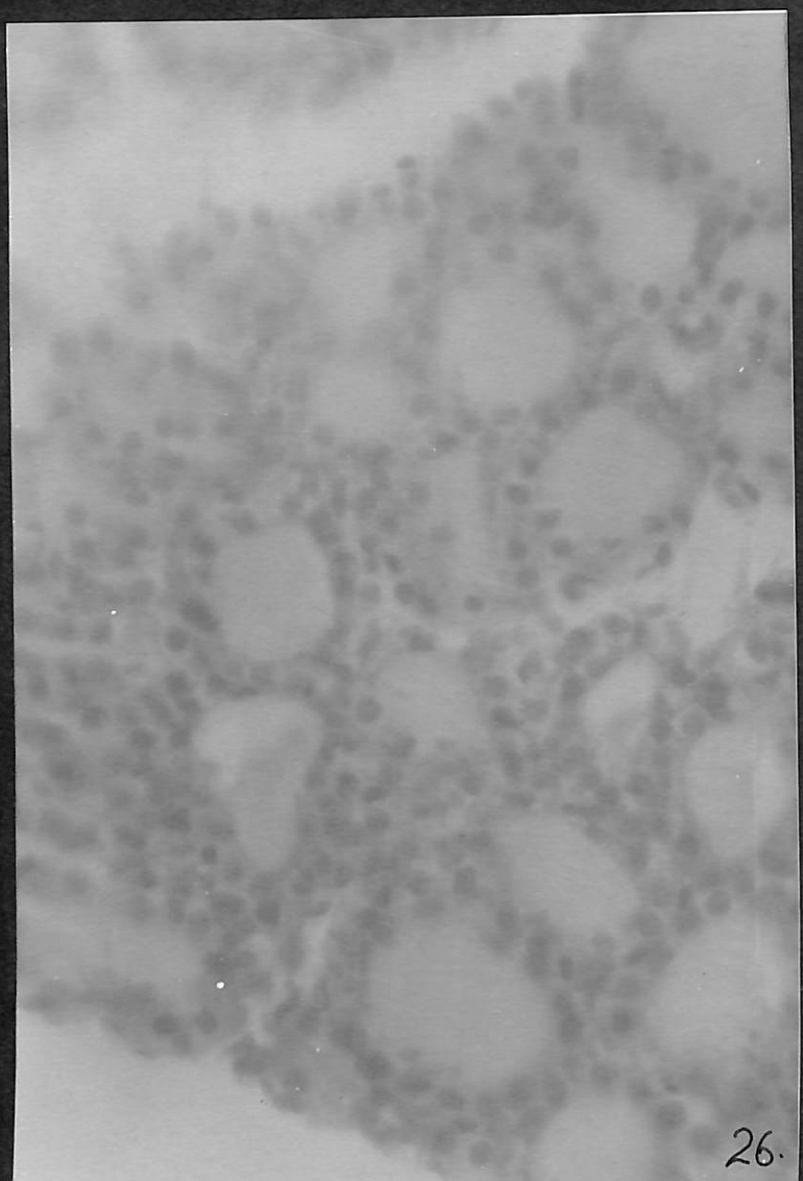

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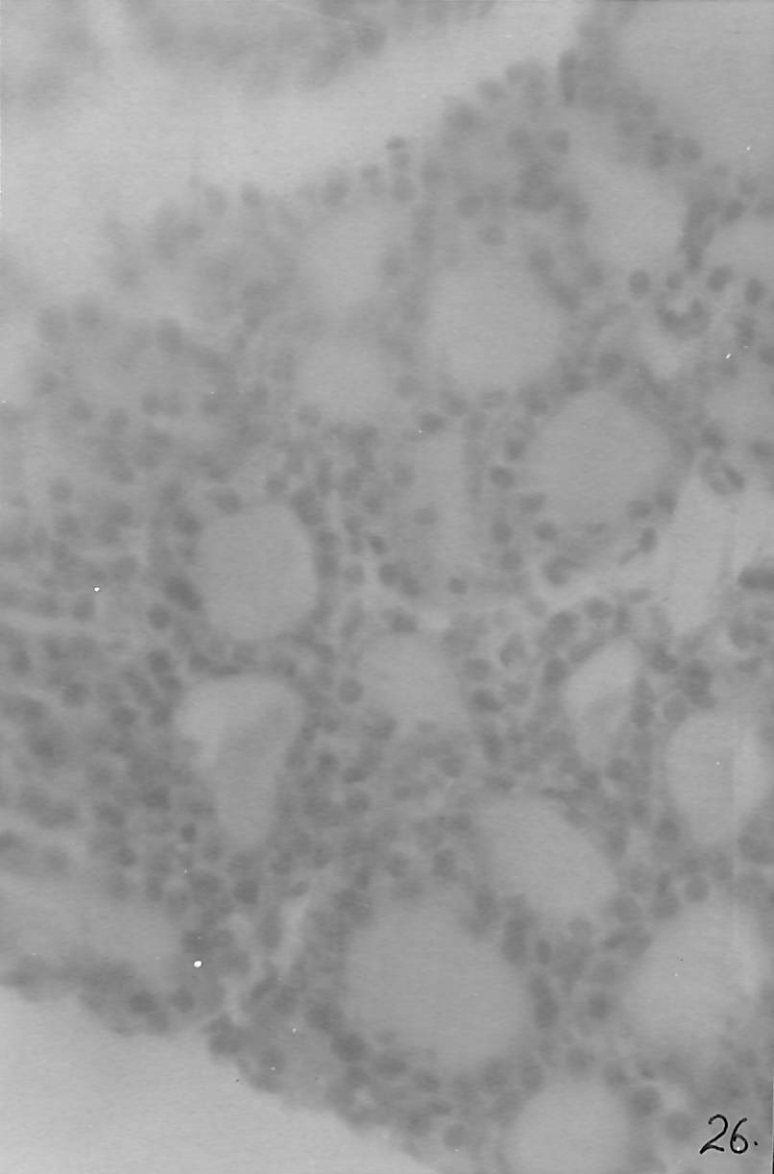

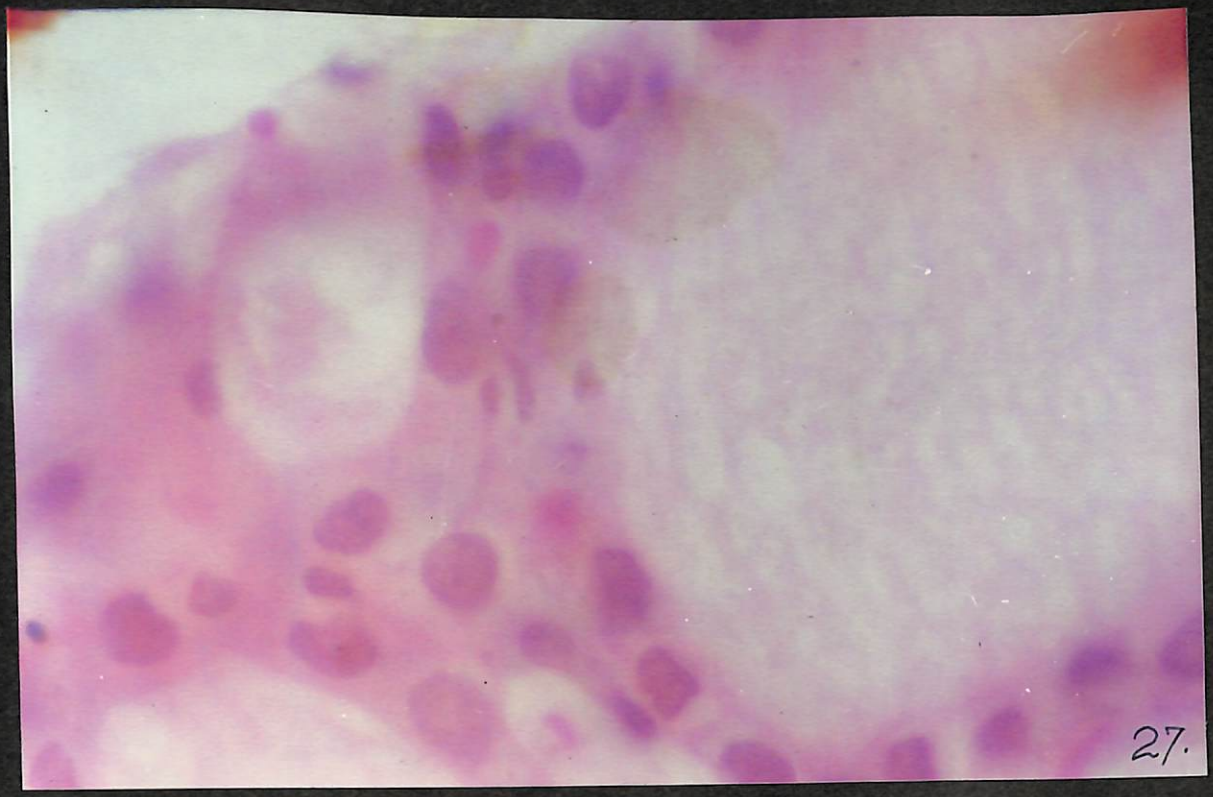

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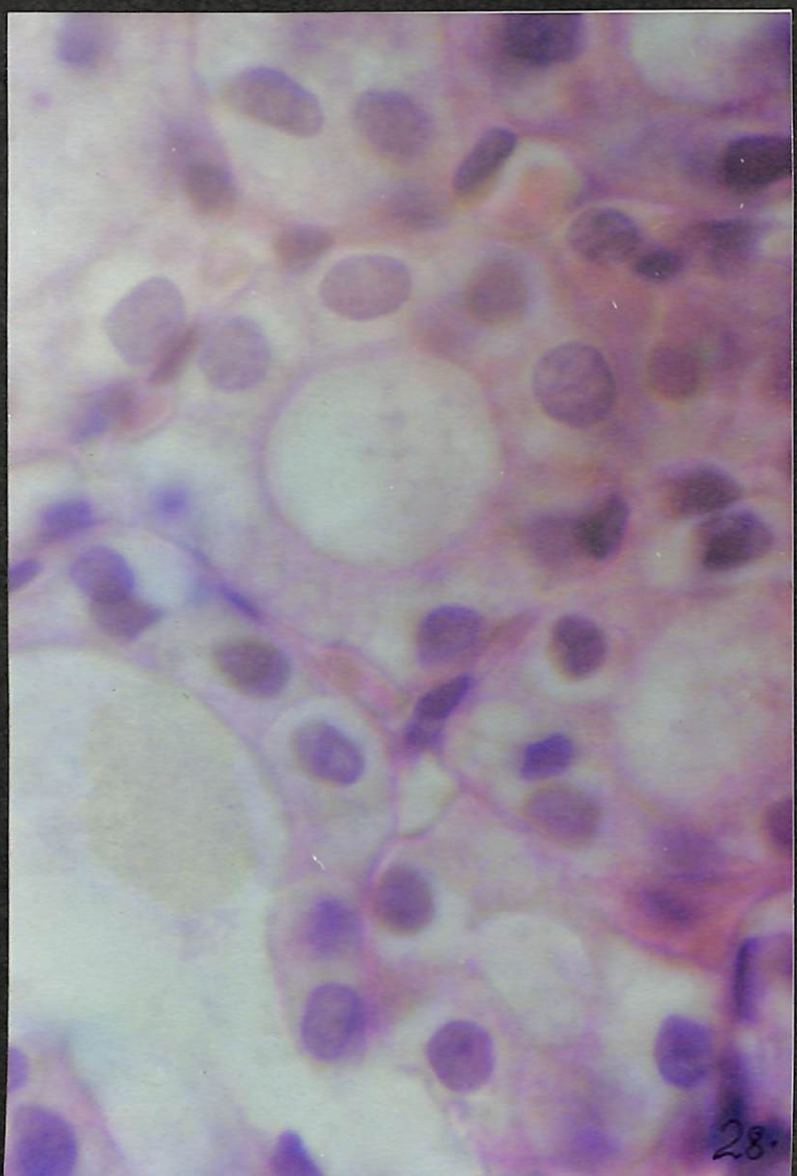

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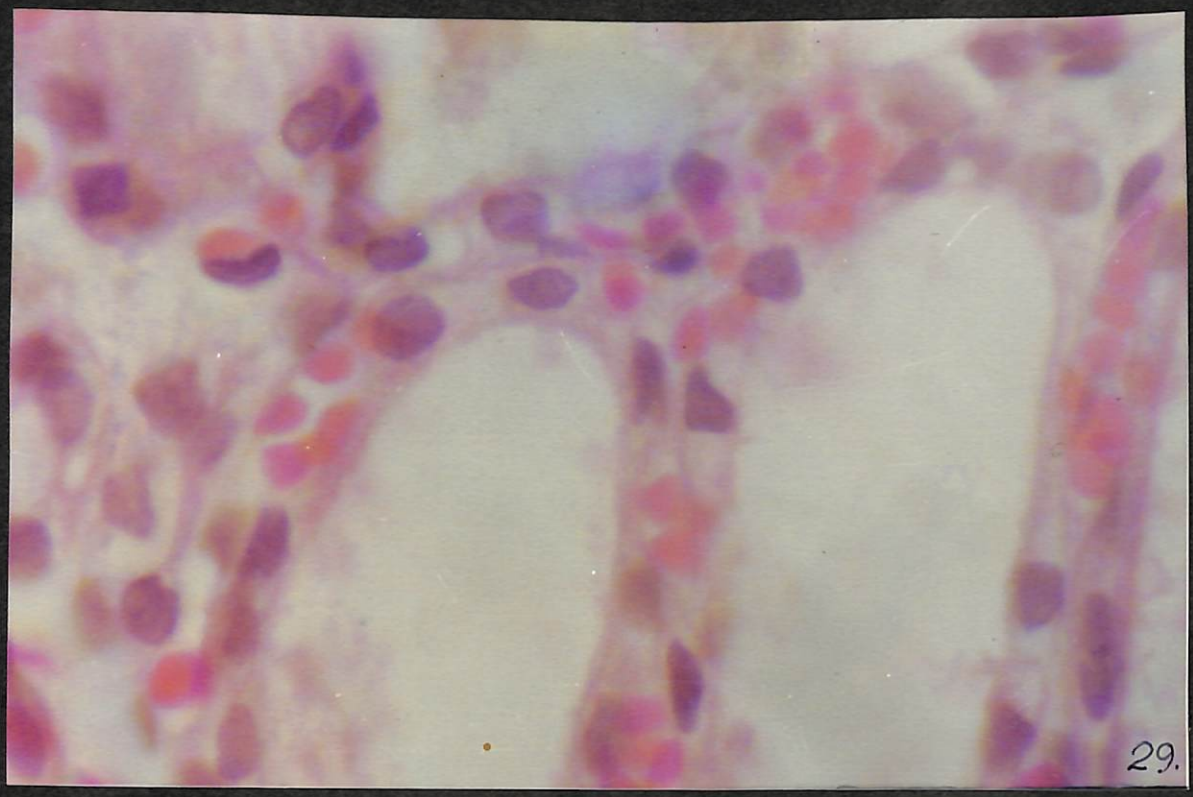

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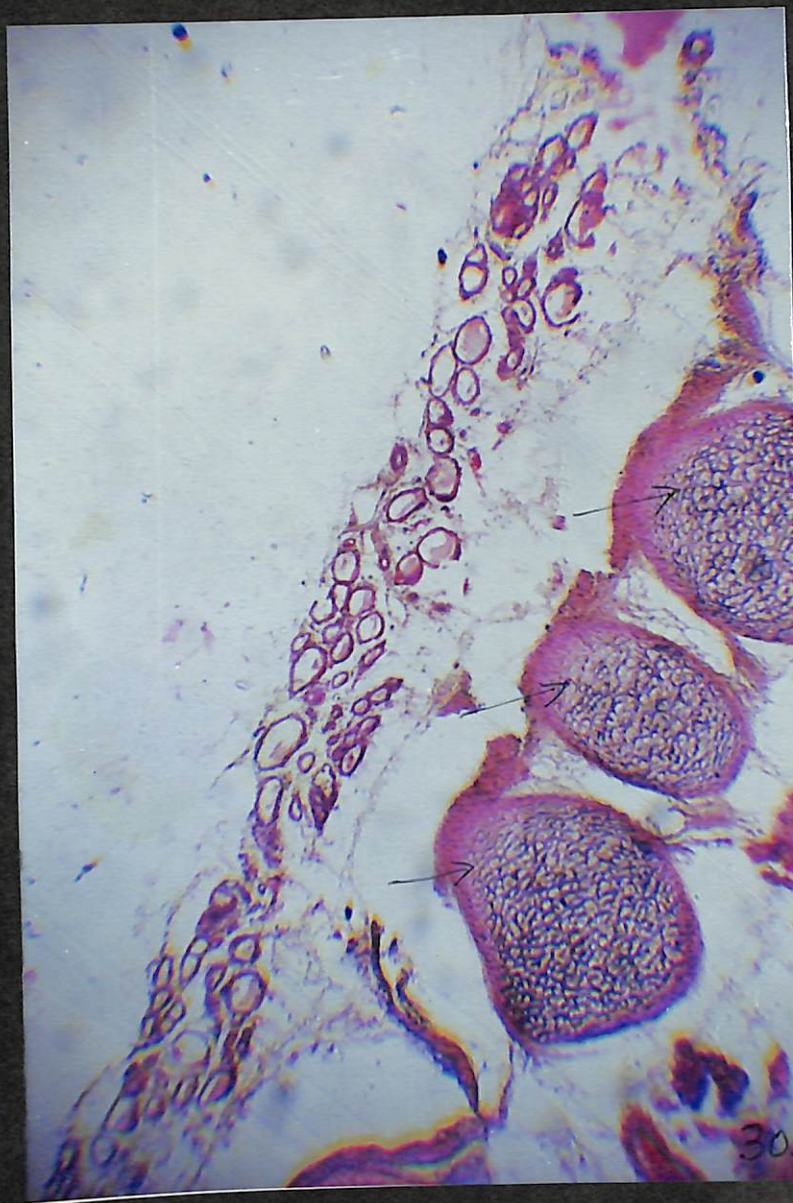

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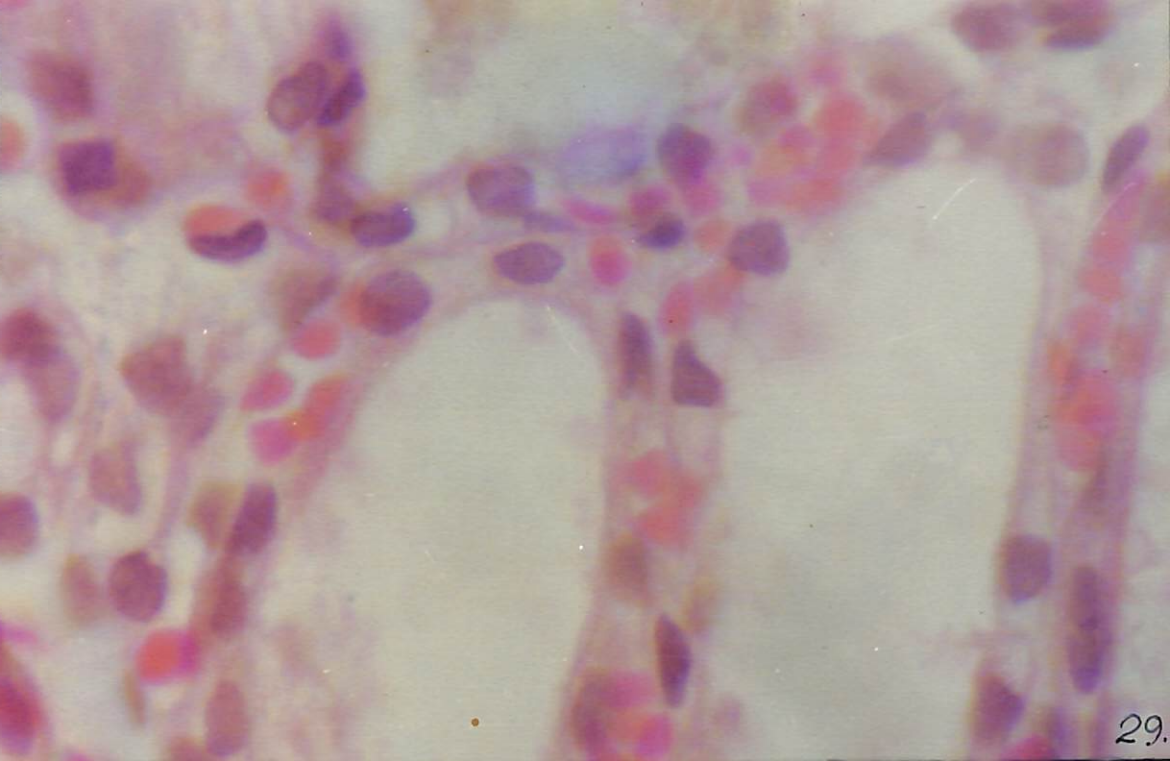

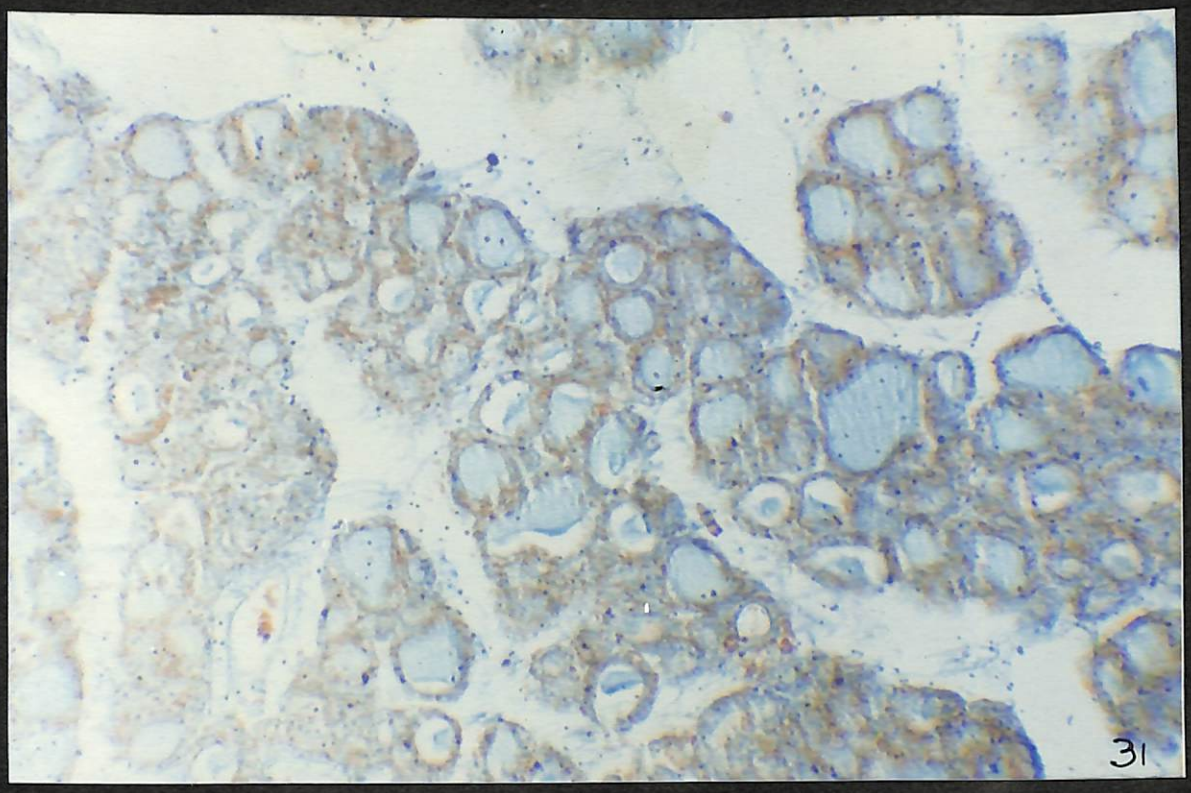
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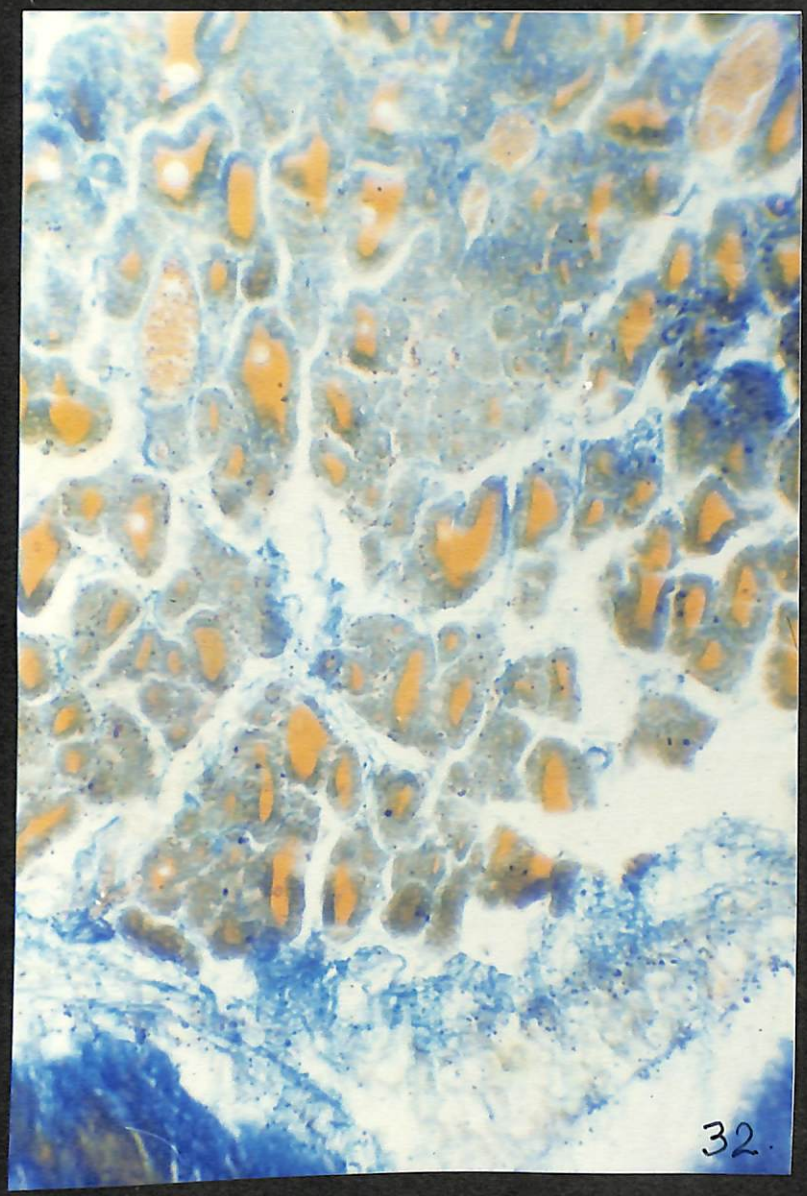
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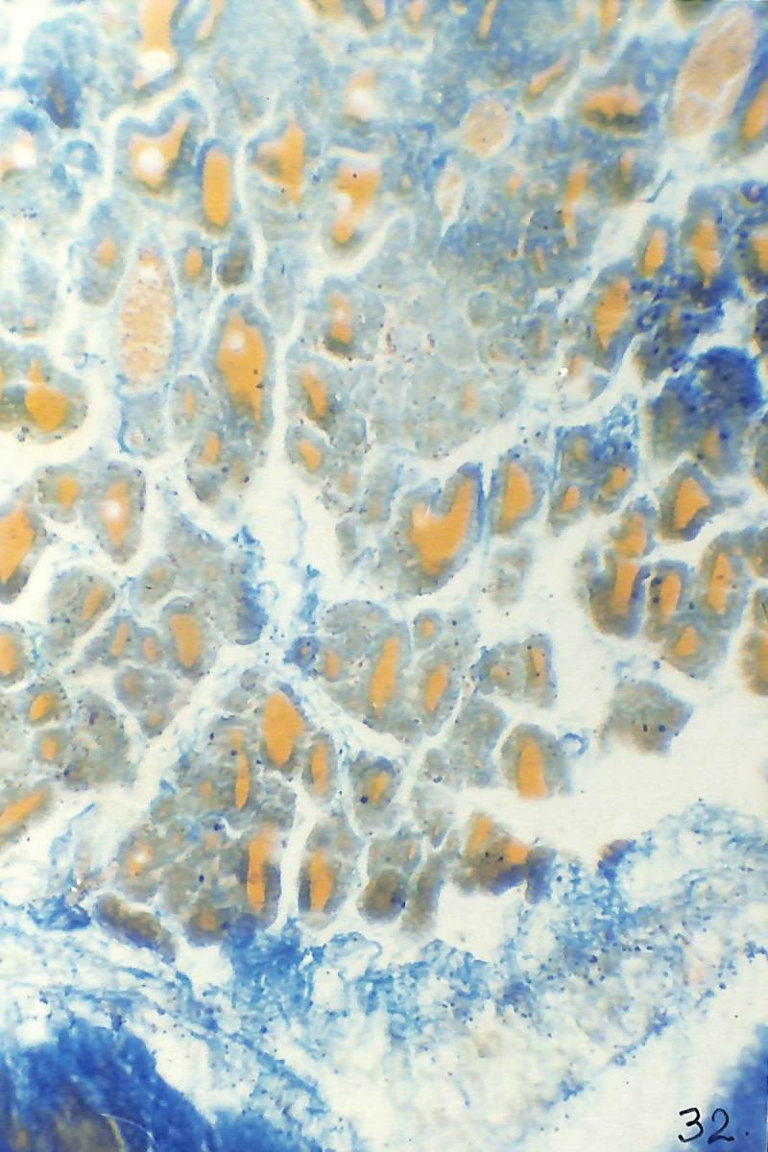

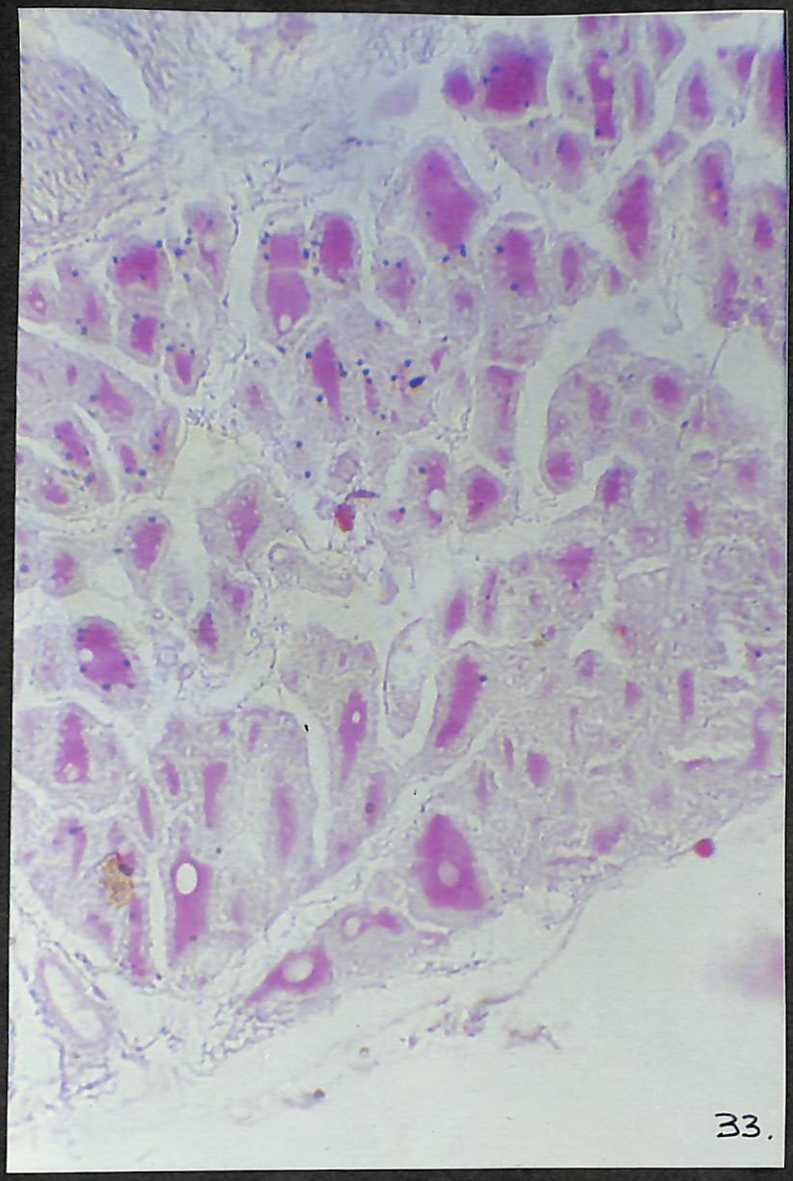

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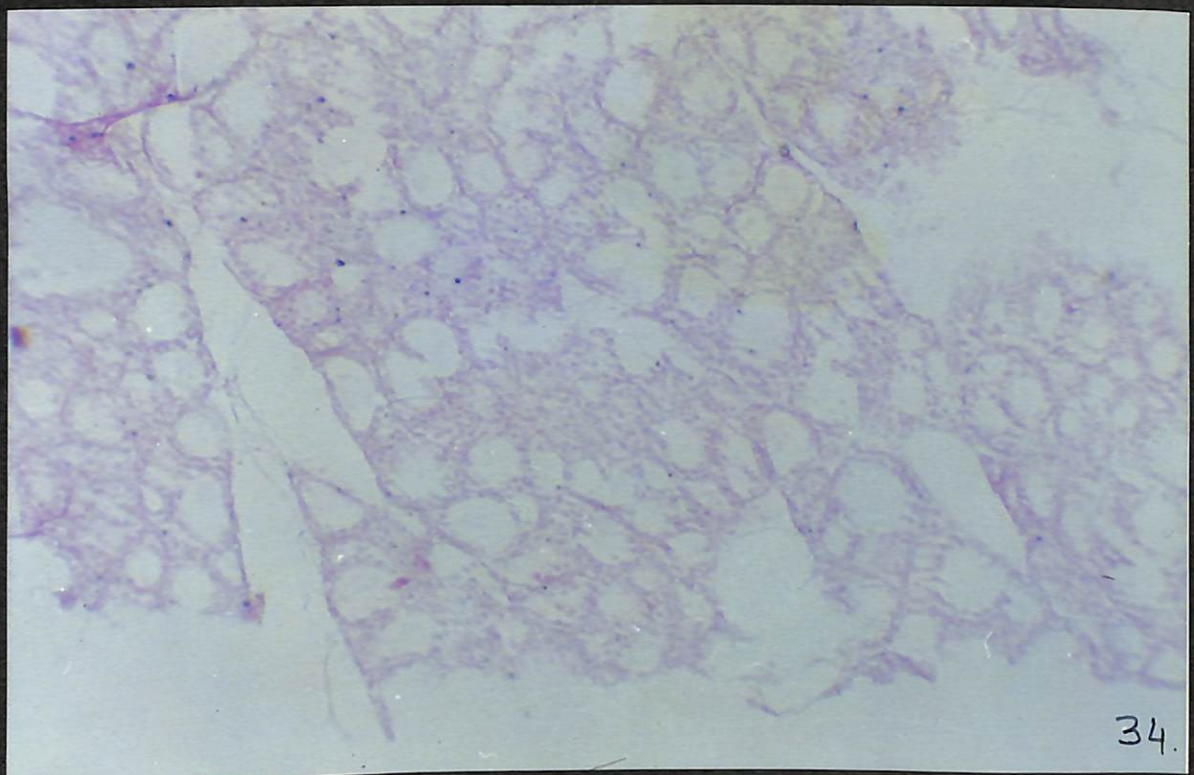

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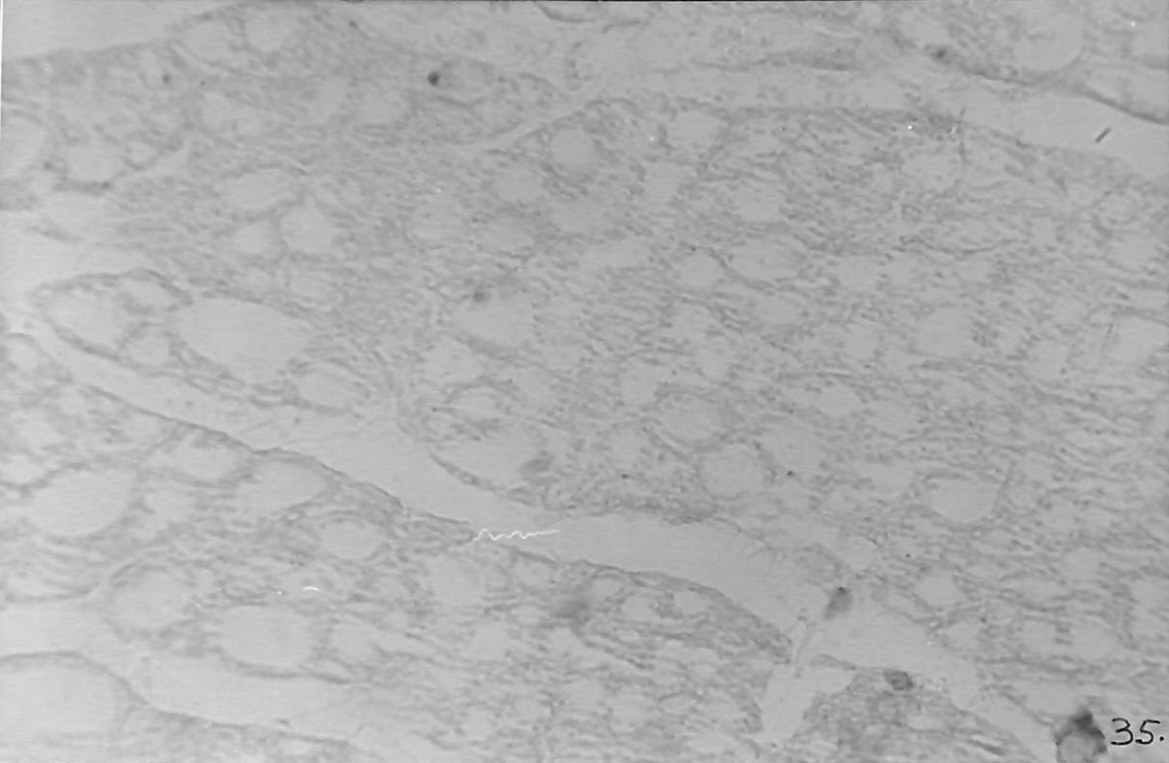

ISTOMORPHOLOGICAL STUDIES ON THE DRENAL AND THYROID GLANDS OF RABBIT

(Oryctolagus cuniculus)

THESIS

SUBMITTED TO THE

RAJENDRA AGRICULTURAL UNIVERSITY

PUSA (SAMASTIPUR) BIHAR

(Faculty of post-graduate studies)

In partial fulfilment of the requirements

FOR THE DEGREE OF

MASTER OF VETERINARY SCIENCE

(VETERINARY ANATOMY)

BY

RENU SINHA

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